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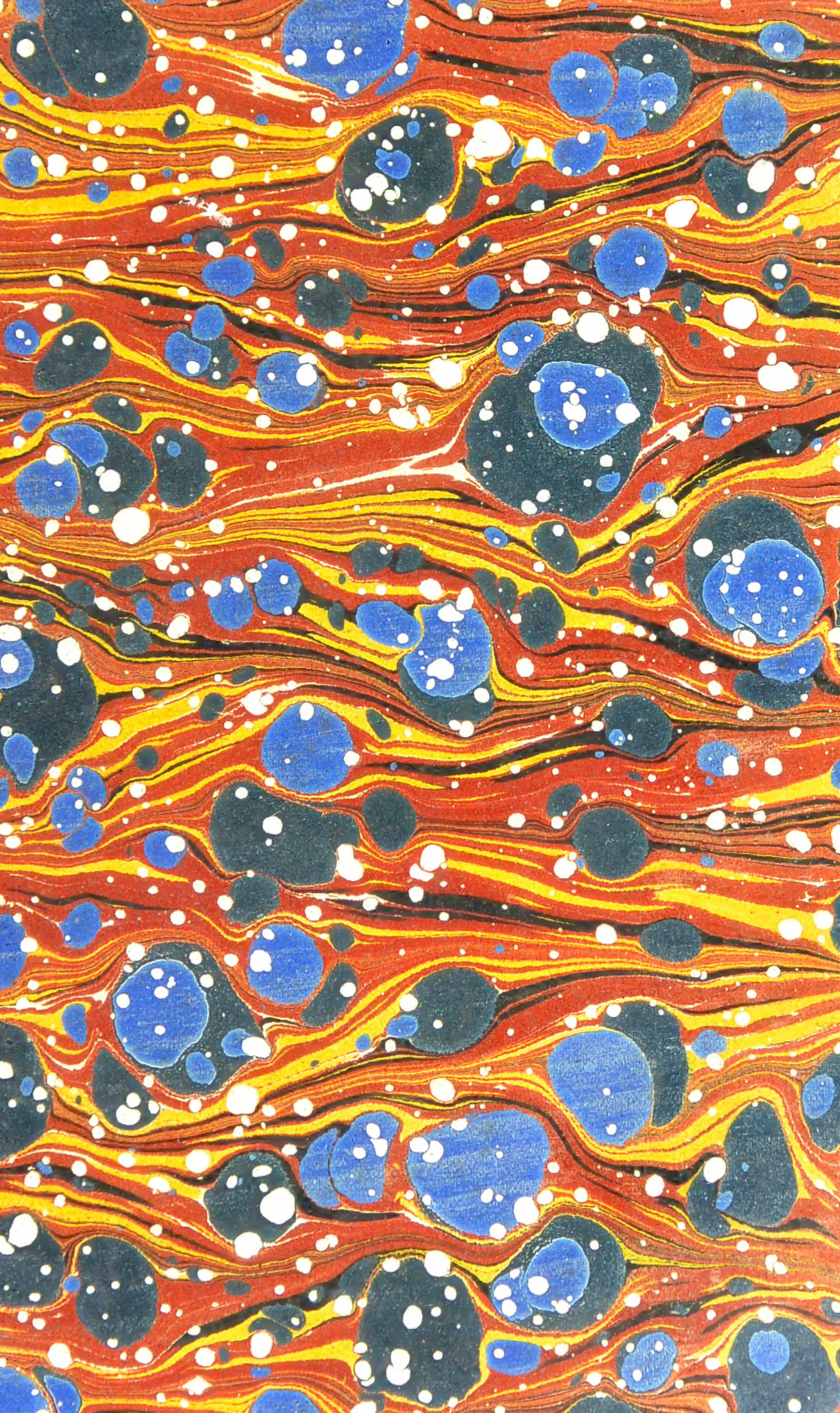

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A

SYSTEM OF SURGERY,

THEORETICAL AND PRACTICAL,

IN

TREATISES BY VARIOUS AUTHORS.

EDITED BY

T. HOLMES, M.A. CANTAB.

ASSISTANT SURGEON TO ST. GEORGE'S HOSPITAL AND TO THE HOSPITAL FOR SICK CHILDREN.

IN FOUR VOLUMES.

VOLUME THE SECOND.

LOCAL INJURIES. DISEASES OF THE EYE.

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It has been thought desirable so far to depart from the order of subjects announced in the Preface as to place the Essay on Diseases of the Eye before those which treat of the Principles of Operative Surgery. The special nature of the former subject appeared to the Editor to render it, to a certain extent, a matter of indifference in what part of the work it was placed; while the arrangement of the book was facilitated by putting that Essay in its present position.

In reference to a statement made on page 81, line 32, the Editor is requested by Mr. Longmore to mention, that the number of cases of union after gunshot fracture of the femur in the upper third which have reached Fort Pitt from the late mutiny in India has increased to *six* since that page was in type.

CONTENTS OF THE SECOND VOLUME.

GUN-SHOT WOUNDS.

By T. Longmore, Esq.

DEPUTY INSPECTOR-GENERAL OF HOSPITALS, PROFESSOR OF MILITARY SURGERY AT FORT PITT, CHATHAM.

PART
I. GUN-SHOT WOUNDS IN GENERAL: PAGE

Definition of the term 1
History of the surgery of gun-shot wounds 1
Varieties of gun-shot wounds 5
As occasioned by the form and nature of the missile (direct and indirect) 5
,, ,, degree of velocity 9
,, ,, number of wounds received . . 11
,, ,, spent balls 12
,, ,, lodgment of balls and missiles, foreign bodies, &c. 13
Internal wounds without external marks . . . 18
Varieties depending on the seat of injury . . . 20
,, ,, ,, varying course of balls . . 20

Symptoms of gun-shot wounds—

Diagnostic symptoms 23
Appearance of wound from various kinds of projectile . 23
Apertures of entrance and exit 25
Pain of gun-shot wounds 28
Shock of ,, ,, ... 28
Primary hæmorrhage 30
Prognosis of gun-shot wounds 32
Treatment of gun-shot wounds in general 33
Progress of cure 42

II. GUN-SHOT WOUNDS IN SPECIAL REGIONS OF THE BODY.

Gun-shot wounds of the head 43
Of the scalp and pericranium 44

PAGE
Gun-shot wounds complicated with fracture of the skull, without depression 46
„ „ „ depressed fracture . . . 47
„ with penetration of the cerebrum . . 48
Treatment of gun-shot wounds of the head . . . 49
Gun-shot wounds of the spine 51
„ „ face 53
„ „ chest 55
„ „ non-penetrating . . . 56
„ „ penetrating 57
„ „ Treatment of these wounds . 59
„ „ of the heart 62
„ „ neck 63
„ „ abdomen 65
„ „ non-penetrating . . . 66
„ „ penetrating 66
„ „ of the diaphragm . . . 70
„ „ Treatment of these wounds . 70
„ „ perinæum and genito-urinary organs 71
„ „ extremities 73
„ „ upper extremity . . . 75
„ „ lower „ . . . 78
Amputation in gun-shot injuries 84
Secondary hæmorrhage in gun-shot injuries 86
Wounds of nerves „ „ 87
Tetanus „ „ 89
Hospital gangrene and pyæmia „ 90
Anæsthesia in operations for gun-shot wounds . . . 91
After-usefulness of wounded soldiers 94

INJURIES OF THE HEAD.

By Prescott Hewett, Esq.

SURGEON TO ST. GEORGE'S HOSPITAL.

Wounds of the scalp. Contusions of the bone 96
Complications of scalp wounds; hæmorrhage 97
„ „ erysipelatous inflammation . 97
„ „ disease of the bones . . 98
„ „ consecutive disease of the membranes of the brain 99
„ „ Trephining for suppuration beneath the cranium 101
„ „ pyæmia 102

Extravasations of blood in injuries of the head.

External to the bone 104
In the diploë 106
Between the bone and dura mater 106

PAGE

Trephining in this injury 108
In the cavity of the arachnoid 109
Formation of false membranes from such extravasations . 109
In the pia mater 111
In the structure of the brain 112

Fractures of the skull:

Of the vault 113
With displacement outwards 113
„ inwards of the outer table only . . 113
„ „ inner „ . . 114
„ „ whole thickness of bone . 114
Compound fractures 115
Diagnosis of fracture of the vault of the skull . . . 116
Treatment „ „ „ . . 117
Trephining in such fractures 117
Pyæmia after fracture of the skull 121
Fractures of the base of the skull, direct 121
„ „ „ indirect 123
Symptoms of fracture of the base 125
Treatment—trephining 129
Union of fractures of the base 129
Separation of the sutures 130

Watery discharges in connexion with severe injuries of the head:

From the ear 131
„ nose 136
„ vault of the skull 138
Concussion of the brain 141
Cases, in which concussion is said to have occurred without anatomical lesion, examined 142
Opinions of various pathologists as to the lesions with which the symptoms of concussion are connected 145
Dissections of recent cases of concussion 146
M. Gama's experiments 148
Symptoms and diagnosis of concussion 149
Frequency of internal extravasation in the so-called cases of concussion 150
Treatment of concussion in its various periods . . . 151
Contusion of the brain—circumscribed 152
„ „ affecting the medulla oblongata or crura . 154
„ „ „ pons Varolii . . . 154
„ „ „ cerebellum 155
„ „ „ cerebrum 155
Diffused contusion of the brain 157
Regions in which contusion occurs most frequently . . . 159
Question of diagnosing contusion and laceration of the brain . 160
Healing and other terminations of contusion 162

Protrusion of the brain-substance (hernia cerebri):

Immediate protrusion 163
Consecutive „ 164
Various forms of consecutive protrusion 165
Treatment of hernia cerebri 169

PAGE
Injuries of the cerebral nerves 170
First pair (olfactory) 171
Second pair (optic) 172
Third „ 173
Fourth „ 174
Fifth „ 175
Sixth „ 176
Seventh „ 177
Eighth and ninth pair 177
Traumatic inflammation of the brain and its membranes . . 179
Of the membranes 180
„ substance of the brain . . . 183
Symptoms of traumatic intracranial inflammation . . . 187
Question of differential diagnosis in these cases . . . 189
Treatment of traumatic intracranial inflammation . . . 189
Trephining for inflammation and abscess within the skull . 192

INJURIES OF THE BACK.

By A. Shaw, Esq.

SURGEON TO THE MIDDLESEX HOSPITAL.

Provisions, in the structure of the spine, against injury . . . 197
Sprains of the back 199
Fractures and dislocations of the spine 203
Fracture from indirect force 204
„ „ direct force—Dislocation 206
Injuries of the spinal cord consequent upon fracture . . 207
Fractures in the lumbar, dorsal, and cervical regions distinguished by the varieties in their effects.
Consequences of destruction of the spinal cord from fracture stated generally 209
Effects of fracture below the second lumbar vertebra . . 210
„ „ in the dorsi-lumbar region 211
„ „ in the two lower thirds of the dorsal region 211
„ „ between the fourth dorsal and third cervical vertebra 212
„ „ of the atlas and axis 215
Bed-sores, consequent on paraplegia from fracture of the spine . 217
Disease in the urinary organs induced by fracture of the spine . 221
Prognosis in cases of paraplegia from fracture of the spine . . 225
Cases of recovery from fracture of dorsal vertebræ . . . 226
Treatment in cases of fracture of the spine 231
Treatment of sloughs and bed-sores 233
On trephining the spine 235
Concussion of the spinal cord 238
Inflammation of the cord and its membranes after fracture . 243

INJURIES OF THE FACE.

By Holmes Coote, Esq.

ASSISTANT SURGEON TO ST. BARTHOLOMEW'S HOSPITAL.

PAGE
General considerations respecting injuries to this part 245
Bruises 246
Injuries of the nerves of the face 249
Wounds of the various features 251
Foreign bodies in the ear 254
„ „ nose 256
„ „ antrum 256
Cicatrices on the face 257
„ between the cheek and gum 258
Hæmorrhage from the ear 259
Fractures of the bones of the face:
„ „ nasal bones 260
„ „ upper jaw 261
„ „ malar bone 261
„ „ lower jaw 261
Dislocation of the lower jaw 268

INJURIES OF THE NECK.

By H. Gray, Esq.

LATE LECTURER ON ANATOMY AT ST. GEORGE'S HOSPITAL.

Wounds of the neck 270
Superficial 271
Involving the upper aperture of the larynx 271
Through the cartilages of the larynx 273
Of the trachea 274
„ trachea and œsophagus 275
Treatment of cut throat 275
Other injuries of the pharynx and œsophagus 281
Other injuries of the air-passages:
Contusion of the larynx 282
Fracture of the hyoid bone 283
Dislocation „ 284
Fracture of the cartilages of the larynx 285
Rupture of the trachea 286
Injury of the larynx from inhalation of flame 288
„ „ drinking boiling water 289
„ „ „ concentrated acids or other irritant fluids 292

PAGE
Foreign bodies in the air-passages—general symptoms and diagnosis . . . 294
Various kinds of foreign bodies which have been found in the air-tube . . . 300
Various situations in which foreign bodies may lodge . . . 300
Results of the lodgment of foreign bodies . . . 301
Foreign bodies in the upper aperture of the larynx or the rima glottidis . . . 303
„ ventricle of the larynx . . . 304
„ lower part of the larynx or upper part of the trachea . . . 304
„ trachea . . . 304
In one of the bronchi . . . 306
In the lung . . . 307
Treatment of foreign bodies in the air-passages . . . 307
General account of the operations practised on the air-tube.
Description of the operation of laryngotomy . . . 310
„ „ tracheotomy . . . 311
„ „ laryngo-tracheotomy . . . 314
After-treatment . . . 315
Indications for these operations in injury and disease . . . 317
Foreign bodies in the pharynx . . . 319
Treatment of such cases . . . 320
Foreign bodies in the œsophagus . . . 321
Treatment of such cases . . . 323
The operation of œsophagotomy . . . 327
Table of cases in which this operation has been performed . . . 329
Injury of the pharynx or œsophagus from drinking the concentrated acids or other irritant fluids . . . 330
Treatment of such cases . . . 334
The operation of gastrotomy . . . 336
Table of cases in which this operation has been performed . . . 338

INJURIES OF THE CHEST.

By Alfred Poland, Esq.

ASSISTANT SURGEON TO GUY'S HOSPITAL.

General considerations . . . 340
I. Injuries and wounds of the parietes (non-penetrating):
Contusions of the chest-walls . . . 341
„ „ with fracture of the ribs . . . 342
Complications of fractured ribs . . . 344
Diagnosis and prognosis . . . 344
Treatment . . . 345
Contusions of the chest, with fracture of the costal cartilages . . . 347
„ „ „ sternum . . . 348
Sequelæ of contusion . . . 350
Wounds of the parietes . . . 350
Complicated with injury to vessels or bones . . . 352
Emphysema in non-penetrating wounds . . . 352

II. Injuries and wounds of the contents of the chest: PAGE
  1. Wounds of the pleura and lung (penetrating) . . . 353
    Of the pleura alone 353
      Hernia of the lung 355
    Of the lung 358
      Diagnostic symptoms 358
      Prognosis and treatment 359
      Primary complications of wound of the lung, viz.:
        a. Emphysema 360
          Treatment of emphysema . . . 361
        b. Pneumothorax 363
        c. Hæmothorax 364
        d. Foreign bodies 366
      Secondary complications. The operation of paracentesis thoracis 368
  2. Wounds of the mediastina, pericardium, and heart . . 374
  3. „ intercostal, internal mammary, and other large vessels in the chest 379
  4. Wounds of the œsophagus 384
  Rupture of the thoracic viscera, without wound . . . 385

INJURIES OF THE ABDOMEN.

By George Pollock, Esq.

SURGEON TO ST. GEORGE'S HOSPITAL.

Division of the subject 388
Contusions 388
  Of the parietes only 389
    Discussion of the question whether sudden death ever occurs in contusions of the abdomen unaccompanied by visible lesion of viscera 389
  Contusions followed by inaction of the bowels from inflammation 396
    „ with rupture of muscles 399
      Hernia consequent on this 400
    „ with extravasation of blood 400
      Abscess consequent on this 402
    „ with rupture of the peritonæum 403
Rupture of the diaphragm 407
Contusions complicated with rupture of the viscera:
  Rupture of the stomach 410
  Rupture of the intestine 411
    Possibility of absence of fæcal effusion 412
    Treatment of this injury 413
    Prognosis 414
  Rupture of the liver 415
    Prognosis 415
    Treatment, immediate and subsequent 417

PAGE
Rupture of the gall-bladder or gall-duct 418
  „ spleen 420
  „ kidney 421
    Prognosis and sequelæ of this injury 422
    Instance of healed rupture 423
    Treatment 423
  Rupture of the ureter 424
Wounds: 1. Without protrusion of the viscera 426
      Foreign bodies in such wounds 427
      Treatment 427
        „ modified in the various regions . . 428
        „ „ by the presence of hæmorrhage 428
        „ of punctured wounds 429
      Symptoms of consecutive suppuration . . . 430
      Ventral hernia after wound of the parietes . . 431
    2. With protrusion of the uninjured viscera . . . 431
      Treatment of such wounds 432
        „ of protruded intestine . . . 432
        „ „ omentum . . . 433
        „ when the intestine is irreducible . . 435
        „ „ „ „ and also strangulated 436
        „ after reduction 437
      Liver protruding 438
      Wound of the vagina with protrusion . . . 438
      Protrusion of spleen, bladder, &c. . . . 439
    3. Wounds of viscera (the intestines); with protrusion of the wounded viscus 440
      Treatment: A small wound should be included in a ligature 441
        „ A large wound should be sewed up . 442
      Treatment of complete division of the gut . . 443
      Process of repair after these injuries . . . 445
    Wounds of the stomach with protrusion . . . 446
    Wounds of viscera in penetrating or punctured wounds 446
      When the stomach is wounded 447
      When the wound is in the intestine . . . 448
      When the liver, spleen, or kidney is wounded . 448
    General conclusions on the subject of wounds of viscera 449
Fistula of the stomach 450
  Instances of recovery from wound and ulceration of the stomach 451
  Treatment of gastric fistula 452
Biliary fistula 453
Artificial anus 453
  External appearances in recent cases 454
  Appearances within the abdomen 455
    After-changes in cases of artificial anus 456
      Prolapsus and hernia from an artificial anus . . . 458
  Treatment of artificial anus 460
    Difficulties occasioned by the *éperon* 461
      Dupuytren's treatment by the *entérotôme* . . . 463
        Results of this treatment 464

PAGE
Foreign bodies in the stomach and intestines 465
  Self-treatment of such cases adopted by coiners . . . 467
    Pins, &c. lodged in the pharynx 467
    Sharp bodies ulcerating through the abdominal parietes . 467
      Question of the travelling of needles 467
  Bodies gradually forming and impacted in the stomach or intestines 468
    Gastrotomy for foreign bodies in the stomach . . . 472
Foreign bodies in the cavity of the abdomen 472

INJURIES OF THE PELVIS.

By J. Birkett, Esq.

SURGEON TO GUY'S HOSPITAL.

I. Contusion of the soft parts 475
II. Dislocation and fracture of the pelvic bones 476
  Partial fracture of the ilium 477
  Fracture of the acetabulum 477
  Fracture and dislocation of the coccyx 479
III. Injuries of the viscera :
  (A) Of the organs of micturition :
    Of the urinary bladder 479
      1. Rupture of the bladder, without fracture . . 480
        " " with fracture not penetrating the organ 484
      2. Wounds of the bladder, from fracture or external wound 485
      3. Rupture from accumulation of secretion . . . 486
      Foreign bodies in the bladder 486
    Of the urethra :
      1. Wounds: incised, longitudinal 489
        " contused and lacerated—complete division 490
      Injury of the urethra from within by the passage of instruments, &c. 495
  (B) Of the organs of generation :
    Of the penis 497
      " prostate gland 498
      " scrotum 500
      " testicles 501
    Rupture of the vas deferens 502
  Injuries of the uterus—
    In the unimpregnated condition 504
    " impregnated " 504
        Contusions without rupture 506
          " with rupture 507
        Rupture during parturition 507

PAGE
Of the vagina 509
„ „ during parturition 510
Foreign bodies in the vagina 512
Of the vulva and external parts of generation . . 512
Of the perinæum 513
(C) Of the organs of defecation (rectum and anus) . . . 514
Foreign bodies in the rectum 515

INJURIES OF THE UPPER EXTREMITY.

By W. H. Flower, Esq.

ASSISTANT SURGEON TO THE MIDDLESEX HOSPITAL.

General considerations 517
Sprains 517
Rupture of muscles 518
„ tendons 518
Displacement of the inferior angle of the scapula . . . 518
Wounds 519
Abscess consequent on wounds of the hand 520
Needles embedded 520
Tetanus after wounds of the hand 520
Wounds involving the arteries 521
Wounds of the palmar arch 521
Preservation of the limb after severe wounds 522
Treatment of compound fracture or dislocation about the elbow 522
Crushing of the hand 523
Statistics of fractures and dislocations of the upper extremity . 524
Fractures: Of the clavicle—body 526
„ „ sternal end 528
„ „ acromial end 528
„ „ incomplete, comminuted, and compound fractures 529
Treatment of fractured clavicle 530
Of the scapula—its body 531
„ „ of the acromion process . . . 533
„ „ „ coracoid „ . . . 534
„ „ „ neck of the scapula . . . 534
Of the humerus.
„ „ (A) Upper end.
1. At the anatomical neck . . 536
„ „ 2. At the line of junction of the epiphysis 537
„ „ 3. Of the surgical neck . . 538
Treatment of these fractures 539
„ „ (B) Shaft 540
„ „ (C) Lower end.
1. Across the lower part of the shaft 543
2. Into the elbow-joint . . 544

PAGE
Of the forearm. (A) Near the elbow.
„ „ 1. Of the olecranon 546
„ „ 2. Of the coronoid process . . 547
„ „ 3. Of the neck of the radius . 548
„ „ (B) In the middle.
„ „ 1. Of both bones 548
„ „ 2. Of the shaft of the ulna . . 551
„ „ 3. Of the shaft of the radius . 551
„ „ (C) Near the wrist.
„ „ 1. Of lower end of the radius . 552
„ „ 2. Of lower end of both bones . 556
„ „ 3. Of styloid process of ulna . 556
Of the bones of the hand. 1. Of the carpal bones . 556
„ „ „ 2. „ metacarpal bones 557
„ „ „ 3. „ phalanges . . 558
Dislocations: Of the clavicle (from the sternum):
1. Forwards 559
2. Backwards 560
3. Upwards 562
Of the scapula (otherwise of the acromial end of the clavicle) 562
Of the humerus 564
1. Subcoracoid 565
2. Subglenoid 570
3. Subclavicular 572
4. Supracoracoid 573
5. Subspinous 573
Partial dislocations 574
Treatment of dislocations of the humerus . 574
Compound dislocations 579
Of the elbow—both bones 579
„ „ of the head of the radius . . . 582
„ the lower end of the radius from the ulna . 583
„ wrist 584
„ bones of the carpus 585
„ thumb 585
„ fingers 587

INJURIES OF THE LOWER EXTREMITY.

By Carsten Holthouse, Esq.

SURGEON TO THE WESTMINSTER HOSPITAL.

General considerations 588
Contusions: of the soft parts 588
of the bones 589
of all the structures of the limb 589
Wounds 590

PAGE
Sprains 591
  Their diagnosis and treatment 592
Fractures :
  Of the femur 593
    Of the neck and upper part of the femur.
      Within the capsule 594
        Union 594
        Causes of intracapsular fracture 595
        Symptoms 596
      External to the capsule 600
        Causes of extracapsular fracture 601
        Union 601
        Symptoms and diagnosis 602
        Prognosis of intra- and extracapsular fracture . . 606
      Fractures partly within and partly without the capsular ligament 607
      Fractures through the trochanter major . . . 607
      Fracture of the epiphysis of the trochanter major . 608
      Treatment of fracture of the neck and upper part of the femur 609
    Of the shaft of the femur 610
        Symptoms and diagnosis 612
        Prognosis 612
        Treatment :—question of the probability of a cure without shortening 613
        Various methods of treatment 615
      Fractures extending into the knee-joint . . . 619
    Of the patella 620
        Symptoms and diagnosis 621
        Pathology ; method of union 622
        Treatment 623
    Of the leg ; both bones 626
        Symptoms and diagnosis 627
        Treatment 628
    Of the fibula alone 630
        Causes of this fracture 631
        Symptoms and treatment 632
    Of the tibia alone 633
    Of the bones of the foot 634
Dislocations :
  Of the hip 636
      Various forms of this dislocation, and the relative frequency of these forms 637
      (1) Upwards, upon the dorsum ilii 638
          Symptoms 638
          Causes and diagnosis 639
          Treatment 640
          Reduction by manipulation 642
          Complicated and old dislocations . . . 643
      (2) Backwards, into the sciatic notch 644
      (3) Downwards, into the obturator foramen . . . 645

PAGE
(4) Upwards and inwards, on to the pubes 646
Anomalous dislocations, upwards 647
" " downwards 648
Of the patella 650
Of the knee 652
Subluxations of the semilunar cartilages . . . 653
Compound dislocations 654
Of the head of the fibula 655
Of the foot at the ankle 655
Outwards, with fracture of the fibula (Pott's fracture) . 656
Inwards 656
Backwards and forwards 657
Compound 658
Of the foot at the calcaneo- and scapho-astragaloid joints . 659
Varieties of this dislocation 660
Diagnosis 663
Treatment 664
Tenotomy in this and similar injuries . . 665
Of the astragalus (properly so called) 666
Treatment 668
Of the os calcis 669
Of the cuneiform bones 670
Of the first from the second row of tarsal bones . . . 670
Of the metatarsal bones 671
Of the phalanges 672

DISEASES AND INJURIES OF THE EYE.

By J. Dixon, Esq.

SURGEON TO THE ROYAL OPHTHALMIC HOSPITAL, MOORFIELDS.

CHAPTER I.

DISEASES OF THE CONJUNCTIVA.

Inflammation of the conjunctiva (*ophthalmia*) 673
" " " from foreign bodies . . . 674
General treatment of conjunctival inflammation 675
Catarrhal ophthalmia 676
Pustular " 678
Purulent " 679
Gonorrhœal " 683
Granular conjunctiva 688
Treatment by inoculation 690
Purulent ophthalmia of infants (*ophthalmia neonatorum*) . . 692
Scrofulous, strumous, or phlyctænular ophthalmia . . . 694
Exanthematous ophthalmia 698
Chronic ophthalmia 699

PAGE
Injuries of the conjunctiva 700
Affections of the subconjunctival tissue:
    Œdema 701
    Pinguecula 702
    Pterygium 702
    Fatty tumours 703
    Cysticercus telæ cellulosæ 703
    Stains from nitrate of silver 704

CHAPTER II.

DISEASES OF THE CORNEA.

Conical cornea 705
Arcus senilis 707
Inflammation of the cornea (*keratitis*) 708
"Chronic interstitial keratitis" 711
Keratitis with suppuration 713
Ulcers of the cornea 716
Opacities ,, ... 718
Injuries of the cornea; Abrasion 720
    Contusion 721
    Incised and punctured wounds . . . 722
Foreign bodies 723
Entozoa in the anterior chamber 726

CHAPTER III.

DISEASES OF THE SCLEROTIC.

Inflammation of the sclerotic 727
Injuries of the sclerotic; wounds 730
Rupture of the sclerotic, with displacement of the lens . . . 730

CHAPTER IV.

DISEASES OF THE IRIS.

Congenital defects 732
Inflammation of the iris (*iritis*) 734
Traumatic iritis 736
Rheumatic ,, ... 738
Syphilitic ,, ... 741
,, ,, in infants 746
Scrofulous ,, ... 748
Gonorrhœal and arthritic iritis 749
Use of atropine 750
Sequelæ of iritis 751
Operations on the iris for artificial pupil 753
    ,, ,, ,, by laceration . . . 755
    ,, ,, ,, by incision . . . 755
    ,, ,, ,, by excision . . . 756
    ,, ,, ,, by ligature . . . 760
After-treatment of cases of artificial pupil 761

CHAPTER V.

DISEASES OF THE CHOROID AND RETINA.

PAGE
"Impaired vision" 763
Muscæ volitantes 766
Choroiditis 768
Retinitis 770
"Amaurosis" 772
The ophthalmoscope 775
Ophthamoscopic appearances of the healthy eye 778
Morbid appearances of the deeper tissues 780
Treatment of "Amaurosis" 787

CHAPTER VI.

DISEASES OF THE VITREOUS BODY.

Synchysis 790
Various morbid deposits 791
Entozoa 791

CHAPTER VII.

DISEASES OF THE LENS AND ITS CAPSULE.

Abnormal position of the lens 793
Cataract; general considerations 794
Congenital cataract 799
Cataract in adults 802
Fluid cataract 804
Traumatic cataract 805
Dislocation of the lens 806
Treatment of cataract 807
Operations by displacement 809
  " " solution 814
  " " extraction 821
  After-treatment of cases of extraction 829
  Prolapsus iridis 836
  Fistulous wound 837
  General remarks on extraction 840
Operations on opaque capsule 843
Extraction of the lens through the sclerotic 845
"Linear extraction" of cataract 845

CHAPTER VIII.

GENERAL AFFECTIONS OF THE GLOBE.

Glaucoma 847
Treatment of glaucoma. Iridectomy 852
Scrofulous and malignant deposits within the eyeball . . . 856

CHAPTER IX.

VARIOUS DEFECTS OF SIGHT.

PAGE
Short-sight (myopia) 859
Long-sight (presbyopia) 861
Faulty perception of colours 862
Hemeralopia and nyctalopia 864

CHAPTER X.

DISEASES OF THE LACRYMAL APPARATUS.

Lacrymal obstruction 865
Treatment of lacrymal obstructions 867
Dacryolithes 872
Diseases of the lacrymal gland and its ducts 872

CHAPTER XI.

DISEASES OF THE EYELIDS.

Epicanthus 874
Entropium 874
Ectropium 876
Trichiasis 876
Inflammation of the lids ; hordeolum 877
Abscess in the Meibomian glands 878
Tinea ciliaris 878
Phtheiriasis 879
Morbid growths of the lids 880
Injuries of the lids 883

CHAPTER XII.

DISEASES OF THE PARTS WITHIN THE ORBIT.

Protrusion of the eyeball (proptosis) 884
Dislocation of the eyeball 885
Hydatid and other tumours in the orbit 858
Abscess in the orbit 886
Affections of orbital nerves 886
Strabismus 889
Removal of the eyeball 892
Use of chloroform in ophthalmic surgery 894

GUN-SHOT WOUNDS.

GUN-SHOT wounds consist of injuries from missiles projected by the force of explosion. As the name implies, this class of wounds is ordinarily restricted to injuries resulting from fire-arms; but it should be remembered, that wounds possessing the same leading characteristics may result from objects impelled by any sudden expansive force of sufficient violence. Injuries from stones in the process of blasting rocks, or from fragments of close vessels burst asunder by the elastic power of steam, offer familiar examples of wounds of a like nature with those from gun-shot. In the following article, however, gun-shot wounds will be considered as they are met with in the operations of warfare.

HISTORY.

From the earliest time of the application of gunpowder to implements of war, down to the present day, the wounds inflicted by its means have excited the most marked interest among Surgeons; nor can this be wondered at, when the immensely superior energy of this agent in comparison with all the mechanical powers previously in use for hostile purposes, and the terrible nature of its effects on the human frame, are remembered. By its introduction the whole aspect of war was changed, in a great degree, by the distance at which opposing forces were enabled to contend with each other; just as, in our day, the nature of battle seems destined to undergo another change from the increased range and precision of fire obtained through the general use of rifled weapons. But though the alterations now being made in the qualities of fire-arms are of the utmost importance to those whose business and especial study is the art of war, to the army Surgeon the interest they excite is chiefly limited to the degree of injury and destruction inflicted by them as compared with weapons of a less perfect kind; while, to the Surgeons employed at the time of the introduction of gunpowder, the wounds were wholly new in their nature as well as degree. Recollecting the ignorance which then prevailed in all departments of science and art, it can excite no surprise that the new engines of war, with the flame and noise accompanying their discharge, were regarded with superstitious terror; nor that Surgeons for a long time found an explanation of the sloughing severity of the injuries they inflicted, and of their difficult cure, in the poisonous nature of gunpowder, or of the projectiles which had been acted upon by it, or in the burning effects of these latter from heat acquired in their rapid flight through the air. Unfortunately, these erroneous views did not end with the theories from which they started, but led to treatment which only aggravated the evils inflicted by the new weapons, and interrupted the progress of the healing action, which nature would otherwise have established. The wound being regarded as a poisoned wound, it was only by a long and tedious process of suppuration that the poison could be hoped to be got rid of from the surface, and prevented from entering the system of the patient. The irritative fever, the wasting and emaciation, and all the other results of the protracted cure of the injury, were so many evidences of the indirect effect of the poison working in the frame; just as the constitutional shock at the time of the wound, the loss of vitality along the surface in the track of a small projectile, or of the tissues laid bare by the passage of the cannon-ball, were regarded as evidences of its direct influence. On looking back at the works of successive writers on this class of injuries, the reader is surprised that the improvement in their treatment has been so gradual and slow; and cannot fail to observe that the chief impediment to a more rapid amelioration of the system pursued has been the prevailing idea of the necessity of delaying the tendency of nature to close the wound, in order that the supposed poison might be eliminated from the constitution. The openings of entrance and exit and track of the ball were incised; the wound dilated by tents or other means, and terebinthinates, or even boiling oil, poured into it; irritating compounds and ointments applied where superficial dressings were practicable; and it was only after the wound was considered to be fully purged of its venom and foul humours by the extensive suppurative action thus kept up, that cicatrisation was permitted to be established.

It required long years of observation in many conflicts, and the exercise of much industry, not to mention moral courage, in opposing authorised custom and prejudice, before a simpler and more rational mode of practice was followed. It is satisfactory to know, that though Continental Surgeons have written more voluminously on the subject of gun-shot wounds, the older English military Surgeons and writers stand forth conspicuously in leading the way to a more practical knowledge of their nature and proper treatment.

Although, however, much that was erroneous was removed by the earlier Surgeons, the light of science can hardly be said to have penetrated this important province of military surgery until the great and last work of John Hunter, on the Blood, Inflammation, and Gun-shot Wounds, was published in 1794. This distinguished philosopher filled some of the highest positions in the British service, having been appointed in 1776 Surgeon Extraordinary to the Army, in 1786 Deputy Surgeon-General, and subsequently Surgeon-General; but he only served abroad about three years, and then only had the opportunity of seeing active service as Staff-Surgeon in the expedition to Belleisle. Had the field of his practical observation been more extensive, there can be no doubt that his zealous and scientific mind would have turned the advantage to the most valuable results for humanity. The physiological principles which he enunciated, based on extensive study and observation in civil life, cannot be controverted; but their practical application, so far as regards the treatment of gun-shot wounds, has been greatly modified since his treatise on the subject was published. There cannot be a better illustration of the special position in which this department of military surgery is placed, from the peculiar circumstances under which it is practised, than the fact, that though men of the highest mental attainments have discussed the subject of gun-shot wounds, we are nevertheless indebted to practical experience in military campaigns for every improvement, some few of recent date excepted, that has occurred in their treatment. Thus, John Hunter was led to advocate very strongly the delay of amputation, after severe gun-shot wounds, for weeks, that the patient's constitution might accommodate itself to the injury; while more extended observation has demonstrated that such secondary amputations are more fatal than those which are performed shortly after the infliction of the wounds leading to them,—the advantage of the patient thus coinciding with what must very constantly happen to be a practice of necessity in the field. Mr. Guthrie remarks, in his Commentaries on the Surgery of the Peninsular War, between 1808 and 1815, that the surgical principles and the practice which prevailed at the commencement of the war were superseded on almost all important points at its conclusion; and he quotes a remark of Sir Astley Cooper, to the effect, that the art of surgery received from the practical experience of that war an impulse and improvement unknown to it before.

The still more recent military operations in Algeria, in Schleswig-Holstein, in the Crimea, and in India, have afforded the opportunity of testing practically the applicability to army practice of some of the great improvements which have been accomplished in the civil practice of surgery in Europe since the termination of the war in 1815. Among these may be particularly enumerated, the avoidance of amputation of limbs, by recourse to excision of joints; resections of injured portions of the shafts of long bones; mitigated amputations, by removal only of those terminal portions of the extremities which had been destroyed by the original injury; and the practice, generally, of what has been styled conservative surgery. In these wars, too, the value of chloroform as an anæsthetic agent in military surgery has been fully established. They have also especially illustrated the influence of various states of health and climates on the results of gun-shot wounds. All the anticipations which were held out at the commencement of some of these campaigns have not been realised, but still they have added much valuable information and many improvements to military surgery.

The alterations made during the last five or six years in the arms of a great proportion of the troops of the leading powers of Europe, and which will, no doubt, be extended to all soldiers in regular armies, namely, the transformation of muskets into "*armes de précision*," with rifled barrels and graduated aims, have led to changes in the severity and almost in the nature of gun-shot wounds from small balls; and the consideration of these changes requires the especial attention of army Surgeons. The effects of the new rifle-balls were widely witnessed during a portion of the period of the Crimean war. The campaign just concluded in Italy will, probably, produce additional practical observations from the Continental Surgeons engaged in it. The fearful proportion of killed and wounded, greater than in any former experience, will have shown the effects not only of rifled muskets, but of rifled cannon also; and, in the French forces engaged, an opportunity will have been afforded of instituting a comparison of the results of their treatment under circumstances of bodily health, and hospital accommodation, very different from those of the French army in the Crimea. It may be hoped that the experience thus gained will advance the knowledge of gun-shot wounds and their treatment a still further stride towards accuracy.

In England, one valuable result which emanated from the late war with Russia was, the regular collection and arrangement, under Government authority for the first time, of the observations and practice of the medical officers employed in the campaign. The value to science of such systematised historical records, if fairly and fully developed, can scarcely be overrated; and it is to be hoped, that henceforth a similar course will be always adopted, whenever the country may become involved in war.

Varieties of Gun-shot Wounds.

Gun-shot wounds are modified in their nature by the form and kind of missile, by the degree of force with which it is propelled, and by the seat of injury. They are, in addition, affected by the circumstances in which the soldier happens to be placed, and by the state of his health when the injury is received.

Form and nature of missile. The projectiles used in warfare of the present day are, cannon and musket shot, shells of various kinds, hand-grenades of iron or thick glass, case-shot, slugs, and other minor varieties of such missiles. These are the ordinary instruments of *direct* gun-shot wounds in warfare; but in addition, there are numerous sources of *indirect* wounds, resulting from the discharge of cannon and musketry. These are stones, or other hard substances, struck from parapets or from the surface of the ground by cannon-shot; splinters of wood from platforms and frame-work, or of iron from gun-carriages; fragments of bone from wounded comrades, or articles in their possession; and any other miscellaneous objects which may happen to come into contact with the solid ball, or shell, in its course.

The objects above enumerated present several varieties of forms. The chief are, 1st, spherical,—as cannon-balls, grape, musket-shot, and shells; 2d, cylindro-conoidal,—as balls belonging to rifled cannon and rifled muskets; 3d, irregular, but generally bounded by linear and jagged edges,—as fragments of shells and splinters.

A gun-shot wound, whether received from a direct or indirect projectile, may be complicated by the entrance of extraneous bodies of various kinds; most commonly, portions of the cloth or buttons of the dress worn by the person wounded. Such foreign substances, though not of themselves causing the wound, often have a special bearing on the progress of its cure.

Not only the form of outline, but the weight, and in some instances the matter of which the missile is composed, influence the nature of gun-shot wounds. In the largest kinds of balls, such as are projected from field-pieces, or guns of position, the form offers little subject for consideration to the Surgeon. So long as there is momentum enough to carry forward the mass of iron of which these missiles are composed, so long will their weight be the most important ingredient in the production of the wounds inflicted by them. Whether the shot come as a solid cone or bolt from one of the new guns, or as a round ball from an ordinary cannon, the injury will be equally destructive to life or limb. The same remark is applicable to the heavier forms of shell, before explosion. The only difference Surgeons may look for from the use of cylindro-conoidal balls, or Whitworth bolts applied to cannon, should they become general, independent of increase in the number of direct wounds from greater power and precision of fire, will be the less number of indirect injuries likely to result from their action, as they neither ricochet, nor roll as "spent balls," in the manner that spherical shot are accustomed to do.

Grape-shot, canister, and spherical case, on striking collectively, that is, before they have spread, as sometimes happens in assaulting or in accidental close proximity to guns in the field, produce the same kinds of injuries as cannon-shot; but, individually, resemble musket-shot in their effects. Wounds from grape-shot are always of a grave character, not only from the extent of the flesh-wound, but also because, from their large diameter and weight, the nerves and vessels of the part struck are less likely to escape injury, if not destruction, than in wounds from the smaller shot projected in canister or spherical case.

With regard to musket-shot, the form presents several features for the consideration of the military Surgeon. In discussing the subject, however, it must not be omitted to be borne in mind, that we have no experience of the effects of round musket-balls propelled with the same amount of force as recent improvements in fire-arms have given to balls furnished with a conical vertex; although, in the old two-grooved rifle, with its belted round ball, a momentum was procured far exceeding that of the common smooth-bore musket. The change in form from the round to the prolonged cylindro-conoidal ball seems to derive its chief importance in surgery from the conical end possessing the mechanical characteristic of a wedge, while the former acted simply as an obtuse body. From this quality the power of penetration of conical bullets is greater, independent of the increased momentum communicated to them by the construction of the weapons from which they are discharged. Thus, supposing one of the old musket-bullets to strike a limb at 80 yards, and an Enfield rifle conical bullet of the same weight at 800 yards, the rate of velocity being similar in each case, the injury from the latter may be expected to be considerably greater than that from the former, on account of its shape. The wedge-like quality of the conical bullet is rendered particularly obvious on its being driven into the shafts of the long bones of the extremities. The solid osseous texture of which the cylindrical portion of these bones is composed, is split up into fragments, having mainly a direction parallel with the central cavity; and fissures not unfrequently extend from the seat of injury to their terminations in the joints, of which they form component parts. Such results were scarcely ever noticed from the impulse of round balls. The bone might be comminuted, but the fragments were of a more cuboid shape, and the long fissuring did not occur. It has been stated, that the screw motion impressed on the ball by the rifling of the musket contributes to its increased power of injury on bone; but its shape, combined with its momentum, seem sufficient to explain the severity of its effects above those of the round bullet. Another result of the tapering form of the conical bullet is, that it is less exposed in its course through soft parts of the body to opposition from tendons, and other long and elastic structures, so frequently noticed to stay the progress of spherical shot. If not dividing them by direct impingement, it readily turns them aside, and it is partly due to this pointed shape, therefore, as well as to increased force, that, as will be noticed hereafter, the lodgment of balls is now so rare in comparison with the experience of former wars.

Much has been written on the comparative surgical effects of bullets of various weights and sizes; but these qualities do not, on consideration, excite so much practical interest in the mind of the Surgeon as it might at first appear they are calculated to do. Some very heavy bullets were used by the Russians in the defence of Sebastopol, nearly one-third heavier than any employed by the troops opposed to them. Such bullets, if of like form and density, and propelled with equal velocity, would obviously inflict injuries, especially against osseous structures, which offer great resistance, wider in proportion to their greater size and momentum; but in respect to simple flesh-wounds, the increased size of the wound left by the larger ball would make little difference in the gravity of the wound, or the time required for its cure, while the escape of foreign substances, which it might happen to carry with it, would be facilitated by the freer means of exit and increased discharge from the surface. Mr. Guthrie mentions, that having had a wide field for observation in the effects of the heavy British musket-ball, sixteen to the pound, on the French wounded, he did not think them more mischievous in their results than the French musket-balls, twenty to the pound, on the English soldiers; while the advantages of carrying a lighter musket and greater number of rounds of ammunition were on the side of our adversaries. It is understood that in warfare the object is not so much to destroy life as to disable antagonists, and the smaller size has been supposed to be fully equal to this object by the British military authorities of the present day; for in the weapon most recently given to the troops, the Enfield rifle, the weight of the ball has been reduced two drachms and a half below that of the ball with the Minié, previously in use. After all, within the moderate limits which must be preserved to suit the circumstances of infantry soldiers, the form and velocity of musket-balls must be the qualities of interest to the Surgeon in connexion with the wounds inflicted by them, rather than their weight or size, as with projectiles from guns of large calibre.

Double bullets, linked together by a spiral coil of wire, something after the manner of chain cannon-shot, were introduced by the Russians during the war in the Crimea. Specimens of these bullets were found about the works around Sebastopol, but no injuries received from them have been recorded; although, after the discovery, peculiarities in the characters of some wounds, which had not previously been satisfactorily accounted for, were supposed to have probably resulted from them. It seems likely, however, that when discharged, the divergent forces impressed on the two bullets were sufficiently great to break apart the connecting wire, which was of very slender diameter, before they came into contact with the troops against whom they were directed. Dr. Scrive, in his *History of the Eastern Campaign*, mentions also that incendiary balls were employed by the Russians. They consisted of a small cylinder of copper containing a detonating composition, and made up into the form of an ordinary cartridge, so as to be discharged from a musket. On hitting its object the projectile burst with violence. These balls were not known till after the conclusion of the siege, and it was only then, M. Scrive remarks, that a key was obtained to some wounds of a frightful character, which could not be accounted for by the action of ordinary bullets, or fragments of shell. No similar observation is recorded in the British surgical history of the war.

Wounds caused indirectly by stones from parapets, splinters of iron or wood, and by fragments of shells, are very varied in character and severity. They derive their importance chiefly from the extent of surface usually lacerated and destroyed. Unless they happen to have penetrated or torn away largely the coverings of vital parts of the body, they are often less grave, though to the sight more fearful, than injuries of less alarming appearance from direct projectiles. In missiles of this secondary kind, the amount of resistance offered to their displacement proportionably diminishes the impetus with which they strike. In like manner, the powerful opposition of the hollow iron shell to the force of the bursting charge within, as well as the shape of the portions into which it is usually rent asunder, combine to cause the momentum of each fragment at starting to be much less, and this momentum to be more rapidly retarded during its flight through the air, than happens in ordinary missiles of direct explosion. The constitutional shock in these injuries is consequently, as a general rule, less than in direct gun-shot wounds. Occasionally simple fractures happen from indirect missiles; from direct they are almost necessarily compound. Although there may be no communication with an external wound, however, there is often great comminution of the bone in these accidents. The laceration and bruising of the soft parts is frequently rendered more dangerous from indirect projectiles, in consequence of large vessels or nerves being implicated in the injuries, leading more often to primary hæmorrhage, and subsequent sloughing of wider tracts, than in wounds from direct projectiles of corresponding size. Such sloughing may lead to a fracture of bone becoming compound which was at first simple. Fragments of shells sometimes wound by falling, after having been projected upwards in the air. These do not generally produce such serious injuries as fragments striking at once from the exploded shell; not that the force is different, but because the parts chiefly exposed—the shoulders, back, &c.—are more protected from injury, and offer less resistance, from relative form and position, than do the abdomen, loins, and other parts of the body, which usually meet the fragments shot upwards when the shell explodes on the ground.

Degree of velocity. The velocity of motion of different projectiles is an important ingredient in the consideration of the several wounds produced by them. The rates of motion imparted to missiles by the fire-arms of early times were probably, from the imperfect construction of the weapons, defective quality of gunpowder, and other circumstances, as inferior to those of the musket lately in use, as the velocity of musket-balls was to that of the conical bullets of the rifles in present use. In a table showing the velocities of certain moving bodies, published in 1851, the common musket-bullet is set down as moving at the rate of 850 miles per hour, the rifle-ball of that time at 1000, the 24-lb. cannon-ball at 1600 miles per hour. But the musket-ball then could not be depended on to hit an object beyond 80 yards, the rifle 200 to 250 yards; while the present Enfield rifle is sighted to 900 yards, and the short Enfield to 1100 yards. The effects of different rates of velocity on wounds are seen in the variations which occur in proportion to the distance which the missile has travelled before inflicting the injury. A cannon-ball which, with but slight velocity of motion added to its weight, would knock a man over, at ordinary speed will carry away a limb without disturbing the general equilibrium of the body. A musket-ball that would be arrested half way through a limb, is now replaced by a ball which, at like distance from the point of discharge, will pass through several bodies in succession.

The increased velocity, or, in other words, greater force, of modern projectiles, exhibits its effects in two directions: locally, by the greater destruction of the tissues in the track of the projectile; and constitutionally, by greater disturbance to the nerve-force of the whole system. The component parts of that portion of the organised fabric through which a bullet, travelling at the rate of several miles per minute, cleaves its way, are inevitably deprived of their vitality. Instances are quoted by authors, of gun-shot wounds having healed by simple adhesion; but such examples are not met with from rifle-bullets retaining their original form. Moreover, when considering the course taken by balls in the body, it will have to be shown that the velocity imparted to projectiles from modern weapons has led to another change in gun-shot wounds. The great power of resistance so often before exhibited by the yielding elastic tissue of the skin, by tendinous and other structures, is no longer of avail against projectiles from modern fire-arms at their usual rates of speed.

The splitting and destructive effects of conical balls on the shafts of the long bones of the extremities have already been mentioned when referring to the peculiarities of their shape. But, together with form, the amount of momentum is a necessary ingredient in estimating this result. The old round balls,—partly from their form, but also from the imperfect mechanism of the firelocks from which they were discharged, and consequent minor degree of velocity imparted to them,—on striking bones, would simply be turned away from the direct line; or, failing this, would knock out a portion of the shaft without further fracture; or, having perforated on one side, remain in the cancellated structure; or be simply flattened without penetrating. It seems not unlikely, also, that the modern conical bullets are denser, from the circumstance of their manufacture by mechanical pressure, than bullets, such as are still used in some places, cast in moulds. The influence of density with respect to power of penetration is very great. In the two most perfect of modern English rifles, the Enfield and the Whitworth, the projectiles and charges being of the same weight, when lead is used, the penetration at 800 yards is one-third greater with the Whitworth than the Enfield; but if a less yielding projectile is used (as when the lead is mixed with tin), its penetration is as 17 to 4 at 800 yards. Whether this cause operates or not, the fact is certain that conical balls in action exhibit almost invariably an overpowering force over all the structures, bone included, with which they come into contact in the human body, and are rarely met with flattened, or so much altered in form as bullets not unfrequently were formerly under like circumstances.

Number of wounds in battle. The increased velocity of modern projectiles, together with the more rectilinear path in which they move, causes a greater number of wounds in modern warfare. The difference which has existed in the proportion of wounded to shots discharged in recent engagements, compared with the experience of former wars, is most marked. It is well known that from expansion of the bore of the musket in use a few years since, and consequent increase in the difference between its diameter and that of the bullet, after a few rounds of fire musket-balls rolled out in numerous instances in the act of elevation of the musket previous to discharge. Now every shot is propelled to a great distance, and with force sufficient, if brought into collision early in its flight, to penetrate and wound several persons. Colonel Wilford, Chief Instructor at the Government School of Musketry, stated publicly in a recent lecture the fact, that 80,000 rounds of ball-cartridge were fired from the old musket in one day in Caffraria, and only 25 Caffres were known to be hit; while at Cawnpore, one company of soldiers, armed with the Enfield rifle, brought down 69 out of a body of horsemen by whom they were attacked, at one discharge. At the battle of Salamanca only one ball in 3000 fired by the British took effect. Another result is, that we may now expect to meet more frequently the occurrence of several bullet-wounds in the same individual. It is mentioned that among the wounded from Solferino, it was not uncommon to see several wounds of different origins in one body; and M. Appia mentions a case in one of the hospitals at Brescia, where a soldier had been struck at the same time by four balls. These circumstances become important in estimating the amount of surgical attendance that is required in modern engagements. At the battle of Solferino, just referred to, some returns show that, in twenty-four hours, 11,500 French, 5,300 Sardinians, and 21,000 Austrians, were laid *hors de combat.* The surgeons had no time to attend to the first necessities of a great proportion of the wounded. A multitude of those unfortunates were hastily conveyed to the little village of Castiglione, and had to wait hours, many even days, before their wounds could be dressed. To relieve thirst, and apply wet compresses of linen to ease the pain of the wounds, by calling into service the people of the neighbourhood, was as much as could be done to a great number for the first day or two, on account of the vast number of wounds inflicted by the new weapons. At Brescia, within a short time after this battle, 15,000 wounded were congregated in thirty-eight fixed and temporary hospitals. From the actions in Flanders on the 16th, 17th, and 18th of June 1815, including the battles of Quatre Bras and Waterloo, the returns show the number of wounded, not including those killed in action in the Duke of Wellington's army, to have been rather more than 8000. In the whole Crimean campaign, the total number of British wounded amounted to 11,361, exclusive of men killed in action.

Spent balls. In connexion with degree of velocity the subject of what are called 'spent balls' naturally occurs. . After a cannon-ball has ceased to pursue its course through the air, or to proceed by ricochet, it not unfrequently travels to a considerable distance, rolling along the surface of the ground. When its rate of movement is not much faster than that at which a man can walk, and when to all appearance it might be stopped by the pressure of the foot as readily as a cricket-ball, it yet possesses the power of inflicting serious injury on such an attempt being put into execution. This power is easily understood, if the amount of force is remembered which must still be inherent in the cannon-ball for it to overcome the inertia of its own mass, and the resistance to which it is exposed in passing over the ground on which it is rolling. It is this force, multiplied by the weight of the ball, which gives it the destructive power. If this ball is brought into collision with the foot of a person, such destruction ensues as generally to necessitate amputation. Should it impinge on other parts of the body, as in the instance of a man lying on the ground, it may cause mortal injury to internal organs, and that without exhibiting external evidence of the amount of injury it has inflicted. So also, though powerless to carry away a limb, it may cause comminuted fractures of bones, and extensive contusions of the softer structures.

Lodgment of balls. Low rate of velocity leads to musket and other balls lodging in various parts of the body. When the smooth-bore musket was in common use, lodgment of balls was of frequent occurrence. In the first place, from absence of sufficient initial velocity to effect its passage out of the body; and secondly, from its liability to be diverted from a direct line, a round ball might be arrested in its progress at any distance from its point of entrance. Conical balls lodge when their velocity has become nearly expended before entering the body; or, from peculiarity in the posture of the person wounded, a ball, having had force enough to traverse a limb, may afterwards enter into another part of the body, and lodge. A ball may reach a part so deep, in the muscles of the back, for example, or be so far removed from the aperture of entrance, as to elude all attempts on the part of the Surgeon, at the time of examination of the wound, to discover its retreat. Or it may have reached some position from which the Surgeon fears to take the necessary steps for its extrication, judging the additional injury that would thus be inflicted more mischievous than the probable effects of allowing the ball to remain lodged.

Unextracted balls lead to consequences varying according to the site of lodgment and state of constitution of the patient. If the ball have become fixed in the body of a muscle, or in its cellular connexions, adhesive inflammation may be established around it; and in time a dense sac be thus formed, in which the ball may remain without causing any, or but very slight, inconvenience. M. Baudens asserts, that a cellular envelope is of very early formation around balls lodged in muscular tissues. Although thus encysted, a ball may press upon nerves, and give rise to pain and much uneasiness; or may be so situated as to embarrass the person in certain movements of the body. Foreign bodies not unfrequently change the position of their first lodgment, under the effect of gravitation, or the impulse of muscular actions. The following instance, which occurred to Staff-Surgeon Dr. Daniell, illustrates the distance to which a lodged ball may travel before finding its exit. In the disastrous affair of Malageah, on the west coast of Africa, fought in May 1855, between detachments of the West India regiments and the Moriah chiefs, a man was wounded just below the spine of the scapula, by a shot fired down from an elevation. The aperture was small, no ball could be traced, and the wound healed up rapidly. Six months afterwards, the man attended hospital, complaining of inability to march, and pain about one of his ankles. A red painful swelling and abscess formed over the inner malleolus; disease of bone was suspected; when examination led to the discovery of a small iron ball, of irregular shape, which was removed. No pain or irritation had existed between the shoulder and the foot. When lodged in the lower extremities, balls sometimes form for themselves canal-shaped cysts, along which they can be moved freely on pressure. When, however, the health or other circumstances of the patient are not favourable, the lodgment of a ball with a smooth surface, like missiles of a more angular and irregular shape, may excite inflammation and constitutional disturbance of a very troublesome kind, and keep up a profuse suppurating discharge along the track of the wound, or perhaps lead to abscesses burrowing in other directions. Balls have been known to lodge in bones, without their positions having been suspected, or inconvenience excited by their presence. On the other hand, balls similarly impacted have given rise to disease; and in some bones, as those of the pelvis, have produced such constitutional irritation as to lead to a fatal termination. Balls lodging in the circumscribed cavities of the body, or their contained viscera, require notice elsewhere.

Grape-shot, and even balls of larger size from field-guns, occasionally lodge. The large gaping wounds inflicted by such missiles usually render the detection of their lodgment and position very easy; but still remarkable instances have occurred, where the presence of bodies of this nature of very large size has been overlooked. Mr. Guthrie's experience of the war in the Peninsula led him to record that "it was by no means uncommon for such missiles as a grape-shot to lodge wholly unknown to the patient, and to be discovered by the Surgeon at a subsequent period, when much time had been lost and misery endured." The same distinguished Surgeon mentions a case, where a ball weighing eight pounds was not discovered till the operation of amputating the thigh in which it had lodged was being performed. Baron Larrey describes a similar case. An artilleryman had his femur fractured by a ball, which, according to the man's description, had afterwards struck another artilleryman by his side. On being brought to hospital, no one doubted that the ball, after fracturing the limb, had glanced off; but on amputating, the ball, weighing five pounds, was found in the hollow of the thigh, towards the groin. The wound of entrance was on the outside of the thigh, and the ball had not only fractured, but had turned round the bone. M. Armand, Surgeon attached to the French Imperial Guard, has related the case of a soldier who was brought to the ambulance, after the taking of the Mamelon Vert, in the Crimea, with his left thigh wounded; one opening, such as might be made by a large musket-ball, was found on the outside of the thigh. There was no second opening. On examination, a swelling was detected in the popliteal space, without any external mark of injury, nor much pain on pressure. It was concluded to be the ball; and, on incising, an enormous grape-shot was found. It had turned round the femur without breaking it. M. Armand writes, that the appearance of the wound alone would have led to the supposition that the ball had not lodged, and no one would have suspected that such a thing as a grape-shot had been the cause of it. In the British surgical history of the Crimean war, the case of a soldier of the 1st Royals, who was wounded in the face by a grape-shot, weighing 1 lb. 2 oz., is recorded. The ball lodged at the back of the pharynx, and escaped observation for three weeks. Were it not for experience of many such instances, it would be deemed almost impossible that foreign substances of such size and weight could remain in the body without the knowledge of the patient, if not discovered by the Surgeon. Even with so large a missile as a grape-shot, a Surgeon should not be contented with examining merely by the wound, wide as it usually is, in case lodgment is suspected; it may travel in a direction which may cause its discovery to be very difficult by that track. An officer of the 19th Regiment was struck during the assault on the Redan, on September the 8th, by two grape-shot, at the back of the chest. They entered close to the spine. One of these balls lodged in the inner part of the right arm, below the axilla, whence the writer excised it.

Penetrating fragments of shells, if projected edgeways, almost invariably lodge. In these cases, the appearance of the wound seldom indicates to the observer the true size of the body which has caused the injury. At an early period of the battle of the Alma, a piece of shell, about four pounds in weight, lodged in the buttock of a soldier of the 19th Regiment; and, to extract it, an incision had to be made nearly equal in extent to the length of the original wound. In this instance the concave aspect of the fragment —evidently, by the nature of the curve and thickness, a portion of a very large shell—had adapted itself to the parts lying beneath, while its convex surface so agreed with the natural roundness of the parts above, that it would have been impossible to have arrived at a knowledge of its lodgment, from any change in the external appearance of the parts. Examination by the wound alone gave decided information on the question. Such fragments become very firmly impacted among the fibres of the tissues in which they lodge, and the effused blood fills up inequalities, and rounds off edges that might otherwise show themselves prominently; so that, without due care, their presence is not unlikely to be overlooked at first examination. Dr. Macleod, of Glasgow, mentions that he saw a case at Scutari, in which a piece of shell weighing nearly three pounds was extracted from the hip of a man wounded at the Alma, which had been overlooked for a couple of months, and to which but a small opening led.* But bodies of still more irregular form may lodge in this region, and escape notice. A soldier in a battery in the Crimea was wounded during a heavy artillery fire in the left hip. A twelvemonth afterwards he was in the General Hospital at Chichester, with a narrow sinus, which allowed a probe to pass deeply among the glutæal muscles. On cutting down in the direction indicated, a piece of stone was extracted, upwards of four ounces in weight. This man had passed through several hospitals before his arrival at Chichester.

Bullets scattered from canister, or spherical case, not unfrequently lodge; apparently in consequence of the direct velocity received from the primary discharge being disturbed, and lessened by the force of the secondary explosion of the case in which they were contained.

A small layer of metal, like a portion of one of the coats of an onion, occasionally becomes detached from a leaden bullet, and lodges. The writer was once applied to by a discharged soldier, suffering from some troublesome granulations at the bottom of the left orbit. The globe of the eye had been destroyed nearly two years before by a musket-ball shot from above, which, after traversing the orbit, had descended, and was excised from the right side of the neck. On examining the granulations by a probe, the point came into contact with a hard substance, which further examination showed to be a small projecting point of lead. It proved to be a scale from the bullet which had caused the original wound, being equal in length to half its circumference, and in width, at the broadest part, about a third of the same dimension. It retained the curved form of the bullet from which it had been detached. The following case shows that similar sections may be separated from cylindro-conical as well as from round bullets. An officer of the 41st Regiment was struck in the Crimea by a conical bullet, which destroyed the fore-arm in such a manner as to necessitate amputation below the elbow. Secondary hæmorrhage occurred on the eleventh day, and on the following day the stump was opened and examined. "While searching for the bleeding vessel, a slice of the bullet, about the size of a worn sixpence, was found deeply imbedded in the muscle." In the case of a soldier of the 19th Regiment, who was wounded before Sebastopol in the loin by a conical bullet, which was discharged per anum, and who died in Guy's Hospital of albuminaria, nearly four years afterwards, a small scale of lead from the bullet was found at the post-mortem examination fixed in the spleen. Strange to say, in this instance the lodgment did not appear to have excited any inflammatory action or mischief.

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* *Notes on the Surgery of the Crimean War*, p. 108.

Lodgment of small foreign bodies, angular pieces of metal—as slugs, nails, and others—and of soft textures, as shreds of linen or woollen cloth, often give rise to much inconvenience. The track of a musket-ball may be prevented from healing, and a troublesome sinus formed, by such small fibres of cloth as would hardly attract notice if within means of observation. Although a wound be closed, and apparently healed, if any shreds of cloth remain, it will probably open from time to time, when small fibres may be noticed in the discharge; and this will continue until the whole is thus got rid of. The probability of cloth entering a wound with the conical ball is not so great as it was with the spherical ball, which not unfrequently tore out a little cap, as it were, of cloth in its passage. This is another result of its shape and velocity. John Hunter and others make mention of circular pieces of the skin being cut out by bullets, and then lodging, and acting as foreign bodies in the wounds.

When the Minié-ball, with the iron cup at its base, was first brought into use, Surgeons anticipated that the addition of the iron cup would complicate the ill effects of the wounds inflicted by it. It does not appear that this has proved to be the case. The iron is usually so far driven into the lead by the force of the exploded gunpowder, and so firmly fixed by the alteration in shape and pressure of the lower part of the ball, that it but rarely becomes detached so as to form a separate lodgment.

Gravel and small stones struck up by shells at the time of their explosion, or by shot ricochetting against the ground, often lodge, and give much trouble in their extraction, especially about the face. In the assault of Sebastopol, at the Great Redan, the attacking parties in their approach, the ground being rocky and having been much broken up by shell-explosions, were particularly exposed to such injuries; and in several instances men were placed *hors de combat* by dust and small fragments of stone thus projected, though the injuries were not of a permanently serious character. One case is recorded where both eyes were penetrated and totally destroyed by gravel thrown up by a shell-explosion.

Foreign substances derived from persons standing near a wounded man, sometimes fragments of the bodies of other wounded men, have been already named as occasionally lodging. In a severe injury to the face, which occurred in a man of the 1st brigade of the Light Division, in the Crimea, the Surgeon was at first puzzled by the strange displacement of a part of the upper jaw. After closer examination, and obtaining a clearer view by the removal of clot, it was found that a piece of the jaw of another man, whose head had been smashed by a round shot by his side in the battery, had been driven into the palate, and was there impacted. Among other cases recorded in the *Surgical History of the Crimean War*, is one of a double tooth of a comrade having been found imbedded in the globe of the eye; and another, where a portion of a comrade's skull was removed from between the eyelids of a soldier. In such injuries as these, where one of two men standing side by side is wounded by a portion of the body of his neighbour, the fragment striking is usually detached from a corresponding region with that struck. The late Mr. Guthrie extracted from the thigh of a Hanoverian soldier, on the third day after his admission into hospital, two five-franc pieces and a copper coin. The man had had no money about him previously to the injury, nor pocket to contain any. The coins had been carried from the pocket of a neighbour, who stood before him in the ranks, and who had been hit by the same grape-shot. These coins, flattened out and jammed together by the force of the shot, are in the Museum at Fort Pitt. Similar examples might be multiplied; but sufficient have been mentioned to show the necessity of careful examination in warfare, not only for direct missiles which may effect lodgment in the body, but for many other foreign substances which may be forced in by their agency.

Internal wounds without external marks. Among the wide variety of injuries from gun-shot, there have not unfrequently been noticed cases in which serious internal mischief has been inflicted, without any external marks of violence to indicate its having resulted from the stroke of a projectile. An important viscus of the abdomen has been ruptured, yet no bruising of the parietes observable; symptoms of cerebral concussion have shown themselves, yet no injury of the scalp to be detected. Even bones have been comminuted without any wound of the integuments or appearance of injury. The records of the Crimean campaign afforded not unfrequent examples of such wounds. Two cases occur, in the French records, of fracture of the fore-arm without any external apparent lesion; in one, the internal structures were reduced to a mass of pulp. The difficulty of reconciling the several facts noticed in such instances, together with the vague descriptions by patients of their sensations, led Surgeons to seek an explanation for them in the supposition that masses of metal projected with great velocity through the air might inflict such injuries indirectly by aërial percussion. Either the air might be forcibly driven against the part injured by the power and pressure of the ball in its flight, or a momentary vacuum might be created, and the forcible rush of air to refill this blank might be the origin of the hurt. Electricity has also been called into aid in explaining these injuries. All these hypotheses are now abandoned. So many observations have been made of cannon-balls passing close to various parts of the body, as near as conceivable without actual contact, without any such consequences as those attributed to windage, as to lead to the necessary conclusion that the theory must in all instances have been fallacious. Portions of uniform and accoutrements have been torn away by cannon-balls without injury to the soldier himself. Even hair from the head has been shaved off, and cases are on record where the external ear and end of the nose have been carried away without further mischief.

The true explanation of the appearances presented in those cases which were formerly called "wind-contusions" appears to rest in the peculiar direction, the degree of obliquity, with which the missile impinges on the elastic skin, together with the situation of the structures injured beneath the surface, relatively to the weight and momentum of the ball on one side, and hard resisting substances on the other. Thus, in the case of a cannon-ball passing across the abdomen, as in two instances mentioned by Sir Gilbert Blane, where men were killed by the passage of balls across the epigastrium, the elasticity of the skin probably enabled that structure to yield to the strain to which it was exposed, while viscera were ruptured by the projectile forcing them against the vertebral column. So the weight of a ball passing obliquely over a fore-arm may possibly crush the bone between itself and some hard substance against which the arm may be accidentally resting, without lesion of the interposed skin. Baron Larrey, who examined many fatal cases of this kind, relates that he always found so much internal disorganisation, as to leave no doubt in his mind of its being the result of contact with the ball. He explained the absence of superficial lesion, by the surface having been struck by cannon-balls in the latter part of their flight, when they had undergone a change of direction from straight to curvilinear, and acquired a revolving motion, owing to atmospheric resistance and the effect of gravitation. In such a condition, he argued, they would turn round a part of the body, as a wheel passes over a limb, in place of forcing their way through it; and while elastic structures would yield, bones and muscles, offering more opposition, would be bruised or broken.

In some recently published letters on the wounded in the late campaign in Italy, by M. Appia, this writer states that wounds from massive projectiles having been rare, he had not met with an example of internal destruction of parts with skin preserved intact, and that he had nowhere seen a wound which was attributed to *vent de boulet*. The hypothesis, he remarks, seems generally abandoned. It is presumed that in stating wounds from *gros projectiles* to have been rare, he refers only to the wounded in the hospitals, and that it is to be inferred that the injuries from cannon-shot proved generally fatal in the field.

Seat of injury. A knowledge of the seat of injury from the passage of a ball involves diagnosis of its course, the depth of its penetration, the particular organs or structures injured, and the extent of the injuries to which they have severally been subjected. The course pursued by balls in wounds presents many features of interest. The depth of penetration, in connexion with direction, becomes of great importance when there is question of one of the great visceral cavities being opened. This part of the subject, however, together with that of injuries to the viscera themselves, will be more conveniently considered when treating of gun-shot wounds in their special relations to particular regions. In like manner, the diagnosis of the extent of injury in wounds complicated with fractures of the long bones will be best considered under gun-shot wounds of the extremities.

Course of balls. Of the circuitous and unexpected directions pursued by bullets in their course through the human frame, which were formerly so common, we are not likely to see many instances in future warfare, when the rifle is the weapon chiefly employed. The conical shape of the ball, and the force with which it is propelled, have had the effect, among others already named, of changing this characteristic of the ball from the smooth-bored musket. The latter, bearing a force that scarcely carried it true to a mark at eighty yards, and usually receiving, as it left the firelock, an impulse which caused it to revolve on its axis at right angles with the line of flight, was deflected by the most trifling obliquity of surface, by the resisting obstacle of a bone, by tendons or the aponeuroses of muscles, or even by the elastic resilience of muscles themselves in a state of action, when the relative direction of their fibres was favourably placed to exert this influence. The Enfield cylindro-conoidal bullet, armed with a force that will carry it to a given spot distant 1000 yards or upwards, flies like an arrow, penetrates the softer tissues in a straight line, and on meeting bone, as before noticed, enters it like a wedge. When a bullet of this kind strikes an object point-blank, it is always the apex of the conical part which first meets the object struck; and, if sufficient resistance be met with, it is this apex which becomes first compressed, and turned back. When it strikes a solid object lying nearly parallel with its line of flight, the ball is planed, as it were, from its apex towards its base. In a case, before referred to (p. 17), where a conical ball entered the loin of a soldier of the 19th Regiment, and was subsequently passed per anum, the apex of the bullet was found to be turned and bent round on itself, and the ball generally flattened. On examining carefully the convex surface of the convoluted apex, minute spiculæ of bone were observed to be impacted in its substance. It became evident, therefore, that the ball had struck, probably penetrated through, some portion of the lumbar vertebræ in its course from the loin to the intestine. There were no general symptoms to indicate spinal injury, but, four years afterwards, the opportunity of a post-mortem examination being afforded, the track of the ball through some of the lumbar vertebræ was distinctly traced.*

It will often appear, at first examination, that the track of a wound by the cylindro-conoidal bullet, even at full speed, is widely removed from a straight line, especially when this class of injuries is new to the Surgeon. It is not difficult to understand the apparent irregularity in the line of the wound, when the many varied positions in which the body and its parts are liable to be placed are called to mind, and if, when making the examination, the Surgeon has omitted to place the patient in a similar posture to that he was in when struck. A certain allowance must also be made for the spasmodic actions of the various muscles among themselves, and momentary displacement of other structures, at the instant of receiving the injury.

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* See *Guy's Hospital Reports*, 3d Series, vol. v. 1859,—case of Gun-shot Wound in the Loins, by S. O. Habershon, M.D.

Occasionally, though rarely, an accidental concurrence of circumstances may lead to the conical bullet pursuing a circuitous, instead of a direct, course, especially when, after travelling a certain distance, its speed has become diminished; and, as round musket-balls are not yet wholly discarded from warfare, it is necessary to call attention to the observations which have been made on this subject. Balls have been known to pass round the outer convex, and the inner concave, surfaces of the abdominal and thoracic cavities, sometimes forcing their exit at points nearly opposite to those of entrance, sometimes making a complete circuit. Thus, from simple observation of the line of direction of two wounds, a ball may be supposed to have passed through the thorax or abdomen, while really it may not have penetrated the cavity, but only made its way beneath the integument. In like manner, a lung may be supposed to have been traversed by a ball, not merely from the relative position of the wounds of entrance and exit, but also by some of the characteristic signs of such an injury, when really the ball, after entering the cavity of the chest, has rolled round the costal pleura, never penetrating the lung, but at the most bruising its surface. In the same way, balls have been known to travel round the cranium beneath the scalp, and to have found their way beneath the integuments of the neck, without injury to the deeper structures. Dr. Hennen saw a case where a ball was found lying in a wound by the thyroid cartilage. It had made a complete circuit of the neck, and returned to the spot where it had entered. Cases sometimes occur where two openings are found in a man's shoulder, in such relation that a straight line between them would necessarily pass through the head of the humerus, yet the ball has only made a half-circuit, outside the joint.

Many examples of such injuries will be found in the works of all writers on gun-shot wounds until the recent introduction of rifled weapons, while those who have only seen the latter in use are almost inclined to doubt the accuracy of previous statements on this subject, from not meeting with similar instances in their own experience. In the early part of the late war with Russia, the musket-wounds were nearly all inflicted by the round bullet; but during the year 1855 conical bullets of various shapes and sizes were brought into use by the Russians generally, as they had been for some time previously by nearly the whole of the English army, and a large proportion of the French army. As early as the battle of Inkerman, however, the Russians were partly armed with the Liège rifle, with its conical bullet. Among 3000 wounded from the recent battles of Palestro and Magenta, assembled in the hospitals at Turin, M. Appia, whose letters on the wounded in the late Italian campaign have been before quoted from, writes that he was astonished not to meet one case of a cylindrical ball having taken a curved direction in its passage. He mentions the case of an officer being wounded by a ball, which entered at the epigastrium and passed out by the side of one of the lumbar vertebræ, without penetration of the abdomen; a red mark, or zone, connecting the two wounds and indicating the circuit which the ball had made. In another case, a ball had traversed the chest from right to left, and still had sufficient force to wound the left arm. Both these injuries, however, were caused by spherical balls.

SYMPTOMS OF GUN-SHOT WOUNDS.

The leading symptoms of gun-shot wounds are the diagnostic marks of these injuries, and the constitutional disturbance, pain, hæmorrhage, œdema, and other circumstances with which they are attended. Some of these require to be noticed separately.

Diagnosis. The external distinguishing signs of a penetrating gun-shot wound are generally manifest enough, but exact diagnosis of the nature and extent of the wound is not always so simple as it might at first appear to be. It is necessary to describe, firstly, the external appearances. These, although possessing certain universal characteristics, vary to a wide extent, according to the different forms, already described, of the missiles causing the injuries, their velocity, the part of the body struck, and its position relative to the projectile at the time of injury.

When a cannon-ball at full speed strikes in direct line a part of the body, it carries away all before it. If the head, chest, or abdomen are exposed to the shot, an opening corresponding with the size of the ball is effected, the contiguous viscera are scattered, and life is at once extinguished. If it be part of one of the extremities which is thus removed, the end remaining attached to the body presents a stump with nearly a level surface of darkly contused, almost pulpified, tissues. The skin and muscles do not retract, as they would had they been divided by incision. Minute particles of bone will be found among the soft tissues on one side, but the portion of the shaft of the bone remaining *in situ* is probably entire.

In ricochet-firing, or in any case where the force of the cannon-shot is partly expended, the extremity, or portion of the trunk, may be equally carried away, but the laceration of the remaining parts of the body will be greater. The surface of the wound will be less even. Muscles will be separated from each other, and hang loosely, offering at their divided ends little appearance of vitality; spiculæ of bone of larger size will probably be found among them; and the shaft may be found shattered and split far above the line of its transverse division. The injury to nerves and vessels may be proportionately higher and greater. Occasionally it happens, even where the limb seems to have been struck in direct line, that it is nevertheless not completely detached, but remains connected by shreds of the skin and parts of the tissues, on which the bone, reduced to minute fragments, is mixed with the contused muscles and other soft parts in a shapeless mass.

If the speed be still further diminished, so that the projectile becomes what is termed a "spent ball," there will not be removal of the part of the body struck, but the external appearances will be limited usually to ecchymosis and tumefaction, without division of surface; or even these may be wanting, notwithstanding the existence of serious internal disorganisation. The rationale of such phenomena has been previously described.

Should the cannon-ball strike in a slanting direction, the external appearances of the wound will be similar to those just described, according to its velocity, modified only in extent by the degree of obliquity with which the shot is carried into contact with the trunk, or extremity wounded.

Large fragments of heavy shells generally produce immense laceration and separation of the parts against which they strike, but do not carry away, or grind, as round shot. Ordinarily, the line of direction in which they move forms an obtuse angle with the part of the body wounded. When they happen to strike in a more direct line, so as to penetrate, the external wound, as alluded to under the head of lodgment of projectiles, is mostly much smaller than the fragment itself, from the projectile not having had force enough to destroy the vitality and elasticity of the soft parts through which it entered.

Small projectiles, with force enough to penetrate the body, leave one or more openings, the external appearances of which also vary according to their form and velocity. The appearance of a wound from a rifle-ball, at its highest rate of speed, may be sometimes witnessed in cases of suicide. A soldier, in thus destroying himself, mostly stoops over the muzzle of his firelock, pressing it against the upper part of his body, and springing the trigger by means of his foot. The muzzle is usually applied beneath the chin. In such a case, a circular hole, without any puckering or inversion of the marginal skin, together with dark discoloration of the integument for several inches round, is observed at the wound of entrance. The vertex of the head is shattered; fragments of the parietal and occipital bones, together with small portions of brain, are carried away and scattered about; the bones not broken are loosened from their sutures; the mass of brain is torn to pieces, but held by its membranes; the superficial vessels of the face are distended with blood. These effects are not wholly due to the passage of the ball, but partly to the flame from the ignited gunpowder jetting out at the mouth of the musket, and in part also to the expansive force exerted within the cavity of the cranium, by the gases resulting from the explosion.

When the musket-ball strikes at a distance from the weapon by which it was propelled, but still preserves great velocity, the appearances of the wound are changed. An opening is observed, irregularly circular, with edges generally a little torn; and the whole wound is slightly inverted. There may be darkening of the margin, of a livid purple tinge, from the effects of contusion, or it may be simply deadlike and pale. Should the ball have passed out, the wound of exit will be probably larger, more torn, with slight eversion of its edges, and protrusion of the subcutaneous fat, which is thus rendered visible. These appearances are the more easily recognised, the earlier the wound is examined. They are more obvious if a round musket-ball has caused the injury, than when it has been inflicted by a cylindro-conoidal bullet. Indeed, with the latter, where it has simply passed through the soft tissues of an extremity of the body at full speed, it is usually very difficult to distinguish by its appearance the wound of entrance from that of exit. In medico-legal investigations concerning gun-shot wounds, it must be often a matter of great importance to decide this point; but to the military Surgeon, more especially from the circumstances connected with the new projectiles, it has become a subject of little practical interest. When the indirect and tortuous penetration of balls was the rule rather than the exception, a knowledge of the spot at which the ball entered was often useful in diagnosing the mischief it had probably committed in its passage, and in determining the part of the wound where foreign bodies might be supposed to be carried and to be lodging. When the track of the ball is nearly in a straight line, as now usually happens, such information cannot be looked for from knowing the relation of either opening to the entrance or passage of the missile.

A musket-ball ordinarily causes either one wound, as when after entering it lodges, or, as sometimes happens, from its escaping again by the wound of entrance; or two wounds, from making its exit at some point remote from the spot where it entered; but occasionally leads to a greater number of openings. This last result may happen from the ball splitting into two or more portions within the body, and causing so many wounds of exit. A case occurred to M. Dupuytren, where a ball split against the spine of the tibia; and after traversing the calf of the leg in two directions, entered the other leg at two points,—one ball thus causing five orifices. A case occurred to the writer, in the Crimea, where a cylindro-conoidal rifle-ball with three cannelures, after fracturing the cranium, was cut in two by the upper edge of bone at the seat of fracture, smoothly as if by a sharp instrument. One part glanced off, the other entered the cranium. A strange feature in this case was, that the depressed portion, after admitting the ball, closed up again; so that no aperture, but only a slight depressed line of fracture, was visible.* A somewhat similar case occurred in the 38th Regiment, but the ball appears to have been a round one. M. Huguier has collected some curious cases of splitting of balls, from the records of the French revolution: among others, the division of a ball into two parts, of another into three parts against the supra-orbitar ridge, and of another into three parts against the clavicle. A case is recorded, where a grenadier in Algeria was wounded in five places, all wounds of entrance, by one ball. It was divided into five portions by first striking against a rock at five or six paces from the soldier, the fragments rebounding at various angles. John Hunter mentions the case of a young gentleman who was shot through the abdomen by means of a musket loaded with three balls. In this instance there were only two orifices of entrance and two of exit, one ball having followed in the track of one of the others; "that there were three that went through him, was evident, for they afterwards made three holes in the wainscot behind him, but two very near each other." Had it not been for this proof, it being known that three balls were discharged, a suspicion might have existed that one of the three balls had lodged. The recollection that such accidents may occur will sometimes assist in the diagnosis of doubtful cases.

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* The portion of cranium referred to, with the piece of ball weighing half an ounce, which lodged in the cerebrum, are in the Museum at Fort Pitt.

The number of wounds made by one ball may be increased by its traversing two adjoining extremities of the same person, or even distant parts of the body from accidental relative position at the time of the injury. On the 18th of June 1848, at Paris, a man received a ball in his right arm, above the elbow, which caused a comminuted fracture of the humerus. It then passed across and entered the left arm below the elbow, fracturing the upper part of the radius. Dr. Hennen mentions the case of a man on a scaling-ladder, in which a ball passed from the middle of the upper arm on one side to the middle of the thigh on the opposite side. It is evident, when the ball traverses with sufficient velocity, that these accidents will not unfrequently occur, especially between the upper extremity and trunk. They correspond with such events as more than one person being wounded by the same ball, examples of which were not unfrequently noticed in the trenches before Sebastopol, from enfilading shots, especially prior to the capture of the Mamelon Vert and other outworks; and are said to have been very common in the late campaign in Italy. Should the Whitworth rifle ever be brought into general use, the proportionate number of wounds thus caused from the greater density of the ball, its immensely superior force, and low trajectory, must be still further increased.

The two openings made by one ball may hold such a relative situation as to lead to the mistake of their being supposed to be caused by two distinct balls. A case is recorded where a ball entered the scrotum, and made its exit from the right thigh, without any intermediate mark of its passage; such a wound might lead to an erroneous diagnosis of this sort. Length of traverse, and consequent distance between the two openings, parts of the body brought into unusual relations from peculiarities of posture, and peculiar deflections of the ball, may all be sources of this error.

The appearances of wounds resulting from penetrating missiles of irregular forms, as small pieces of shells, musket-balls flattened against stones, and others, differ from those caused by ordinary bullets in being accompanied with more laceration, according to their length and form. Being usually projected with considerably less force than direct missiles, such projectiles ordinarily lead only to one aperture, that of entrance.

Pain. A gun-shot wound by musket-shot is attended with an amount of pain which varies very much in degree according to the kind of wound, condition of mind, and state of constitution of the soldier at the time of its infliction. It will sometimes happen in simple flesh-wounds, that patients will tell the Surgeon they were not aware when they were struck; and examples attesting the truth of such statements occur, of soldiers continuing in action for some time without knowing they had been wounded. Sometimes the pain from the shot is described as a sudden smart stroke of a cane; in other instances as the shock of a heavy intense blow. Occasionally the pain will be referred to a part not involved in the track of the wound. Lieutenant M. of the 19th Regiment was wounded by a musket-ball at the assault of the Redan, on the 8th of September 1855. His sensations led him to imagine that the upper part of his left arm was smashed, and he ran across the open space in front of the works, supporting the arm which he supposed to be broken. On arriving at the advanced trench, he asked for water; on trying to drink, he found that his mouth contained blood, and that he was unable to swallow. The arm, on examination, was found to be uninjured, but a ball had passed from right to left through his neck, and from its direction had no doubt struck some portion of the lower cervical or brachial plexus of nerves. Immediately after the transit of a ball, the sensibility of the track and parts adjoining is found to be partially numbed, so that examination is borne more readily for a short time after the accident than at any later period. Of course, after reaction sets in, or when inflammation has become established, the pain of the wound is proportionably increased. When a ball does not penetrate, but simply inflicts a contusion, the pain is described to be more severe than where an opening has been made by it.

Shock. When a bone is shattered, a cavity penetrated, an important viscus wounded, a limb carried away by a round-shot, pain is not so prominent a symptom as the general perturbation and alarm which supervene on the injury. This is generally described as the 'shock' of a gun-shot wound. The patient trembles and totters, is pale, complains of being faint, perhaps vomits. His features express anxiety and distress. This emotion is in great measure instinctive; it is witnessed in the horse hit mortally in action, no less than in his rider; it is sympathy of the whole frame with a part subjected to serious injury, expressed through the nervous system. Examples seem to show that it may occasionally be overpowered for a time, even in most severe injuries, by mental and nervous action of another kind; but this can rarely happen when the injury is a vital one. Panic may lead to similar results when the wound is of a less serious nature. A soldier, having his thoughts carried away from himself,—his whole frame stimulated to the utmost height of excitement by the continued scenes and circumstances of the fight,—when he feels himself wounded, is suddenly recalled to a sense of personal danger; and if he be seized with doubt whether his wound is mortal, depression as low as his excitement was high may immediately follow. This will happen according to individual character and intelligence, state of health, and other circumstances. For while, on the one hand, numerous examples occur in every action of men walking to the field-hospital for assistance almost unsupported, and with comparatively little signs of distress, after the loss of an arm or other such severe injury; on the other, men whose wounds are slight in proportion are quite overcome, and require to be carried.

As a general rule, however, the graver the injury, the greater and more persistent is the amount of 'shock.' A rifle-bullet which splits up a long bone into many longitudinal fragments inflicts a very much more serious injury than the ordinary fracture effected by the ball from a smooth-bore musket, and the constitutional shock bears like proportion. When a portion of one, or of both, lower extremities is carried away by a cannon-ball, the higher towards the trunk the injury is inflicted, the greater the shock, independent of the loss of blood. Some writers in accounting for 'shock' lay stress on the concussion, and general mechanical effects on the whole body, of the momentum of the iron shot.* To a certain extent this may be true, but, judging from analogy in physics, the greater the velocity, and consequently the momentum, of a ball carrying away a limb, the less would the concussion of the trunk and distal parts of the body be. A pistol-ball at full speed will take a circular portion out of a pane of glass without disturbing the remainder; if the speed be much slackened, as when fired from a distance, it will shake the whole pane to pieces.

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* In the *Medical and Surgical History of the War against Russia in the Years* 1854-55-56, published by authority, vol. ii. p. 265, the physical effects of concussion in producing 'shock' are strongly dwelt upon. It is remarked: "The shock of the accidents frequently witnessed by the military surgeon differs, often in a very material degree, and possibly in kind also, from that witnessed in civil life. When a cannon-shot strikes a limb and carries it away, the immense velocity and momentum of the impinging force can scarcely be supposed to have no physical effect upon the neighbouring or even distant parts independent of, and in addition to, the 'shock' in the ordinary acceptation of the term, which would result from

That true 'shock,'—*ébranlement* of French writers,—as distinguished from shock resulting from mental depression after unusual excitement, or the effects of groundless alarm on the part of a patient, is a phenomenon the essential relations of which are connected with vital force, and with that endowment of the organisation only, may be judged from observation of cases in which the direct result of the wound is inevitably fatal, including many where no physical effects on neighbouring parts from concussion could possibly be produced. In such injuries the 'shock' remains, from the time of first production of the fatal impression till life is extinguished. And the practical experience of every army Surgeon teaches him that where a ball has entered the body, though its course be not otherwise indicated, the continuance of shock is a sufficient evidence that some organ essential to life has been implicated in the injury. That the shock of a severe gun-shot wound may be complicated with other symptoms, or that some of its own symptoms may be exaggerated from other causes,—hopes disappointed, the approach of death, and all the attendant mental emotions,—scarcely affects the question at issue; for its existence, independent of these complications, in all such cases is undoubted.

Primary Hæmorrhage. Primary hæmorrhage of a serious nature from gun-shot wounds does not often come within the sphere of the Surgeon's observation. If hæmorrhage occur from one of the main arteries, it probably proves rapidly fatal; and Surgeons after an action are usually too much occupied with the urgent necessities of the living wounded to spare time for examining the wounds of the dead, who are mostly buried on the field where they fall. Thus most Surgeons speak of primary hæmorrhage being exceedingly rare, more rare perhaps than it actually is. M. Baudens, referring to

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the removal of the same part by the knife of the surgeon, or the crushing of it by a heavy stone or the wheel of a railway wagon. . . . In the great majority of cases, the whole frame is likewise violently shaken and contused, and probably, independent of these physical effects, a further vital influence is exerted, which exists in a very minor degree, if at all, in the last-named injuries, and may possibly depend upon the ganglionic nervous system."

his service in Algeria, has remarked that he has often found on the field of battle wounded soldiers who had died of primary hæmorrhage.

In those wounds to which the Surgeon's care is called, the primary hæmorrhage is ordinarily small in quantity and of short duration—a sudden flow at the moment of injury, and nothing more. When a part of the body is carried away by round shot or shell, the arteries are observed to be nearly in the same state as they are found to be in when a limb is torn off by machinery. The lacerated ends of the middle and inner coats are retracted within the outer cellular coat; the calibre of the vessel is diminished, and tapers to a point near the line of division; it becomes plugged within by coagulum; and the cellulo-fibrous investing sheath, and the clot which combines with it, form on the outside an additional support and restraint against hæmorrhage. When large arteries are torn across, and their hæmorrhage thus spontaneously prevented, they are seldom withdrawn so far but that their ends may be seen protruding and pulsating among the mass of injured structures; yet, though the impulse may appear very powerful, further hæmorrhage is rarely met with from such wounds. There is more danger of continued hæmorrhage from wounds by pieces of shell, as the arteries are liable to be wounded without complete transverse section of their coats. The sharp edges, less velocity, and oblique direction in which the fragments usually impinge, sufficiently explain this difference.

It comparatively rarely happens that arteries are cut across by musket-bullets, either round or conical. The lax cellular connexions of these vessels, the smallness of their diameters in comparison with their length, the elasticity as well as toughness of the tissues forming their coats, the fluidity of their contents, and, in consequence of all these conditions, the extreme readiness with which they slip aside under pressure, act as means of preservation when these important structures are subjected to such danger as the passage of a musket-ball in their direction. Endless examples occur where the ball appears to have passed through in the direct line of the artery, so that it must have been pushed aside by it to have escaped division. Mr. Guthrie mentions a case where a ball even opened the sheath of the femoral vessels, and passed between the artery and vein, in a soldier at Toulouse, without destroying the substance of either vessel. So close was the ball, and such contusion was produced, together with, doubtless, injury to the vasa vasorum, that the artery became plugged with coagulum and obliterated. A preparation of these vessels is in the Museum at Fort Pitt. Another case is mentioned by Mr. Guthrie, where the direction of a ball between the left clavicle and first rib, and permanent diminution of the pulse in the arm on the same side, led to the conclusion that the subclavian had escaped direct destruction by the missile in a similar way.

Vessels do not always thus happily elude division by the ball. Captain V——, of the 97th Regiment, whose death led to so much interest in England, was struck by a ball which divided the axillary artery on the right side. The arm had apparently been extended when he received the injury, as if in the act of holding up his sword. The night was very dark, the distance from the place where the sortie took place in which he was wounded to the camp-hospital was more than a mile and a half, and he sunk from hæmorrhage while being carried up. The death of an officer from division of the femoral artery is recorded in the *Surgical History of the Crimean War*, where also cases are mentioned, though not immediately fatal, of a wound of the femoral vein and profunda artery in the same subject from a conical bullet; and another, of the popliteal artery and vein, also from a rifle-ball. Mr. Guthrie mentions the cases of two officers who were killed, almost instantaneously, one by direct division of the common iliac artery, the other of the carotid. Primary, but indirect, hæmorrhage, in consequence of a gun-shot injury, usually occurs as a complication of fractured long bones, the sharp points and edges of which, extensively torn up as they now are by conical bullets, are well calculated to cause such injuries. They are not as frequent as might be expected, from the limits within which the dispersion of the fragments is restricted by their periosteal and other connexions, and the yielding mobility, before mentioned, of the vessels themselves. We have no data, however, to guide us in determining the proportionate frequency of fatal results from primary hæmorrhage after wounds; nor can we have them until proper examination and classification of the particular causes of death on the field of battle are instituted.

PROGNOSIS.

Gun-shot wounds vary in gravity from the simplest laceration of cuticle to the instantaneous destruction of life. Death may take place primarily from direct causes already alluded to, viz. from the destruction of vital organs, from extreme shock to the vital forces through the nervous system, or from hæmorrhage; or it may ensue indirectly from secondary hæmorrhage, gangrene, erysipelas, hectic fever, pyæmia, or from the results of operations necessarily required in consequence of the original injury. In estimating the probable issue of a particular wound, not only the state of health at the time, but, if a soldier, the previous service, and diseases under which he has laboured during it, must be taken into account, and the circumstances in which he is placed with respect to opportunity of proper care and treatment must also be carefully weighed. The time which has elapsed after the receipt of the injury is another important matter in forming a prognosis. The difficulties which have been already enumerated in the way of arriving at a safe diagnosis of the true nature and extent of the injury, and the liabilities above mentioned to which a patient with a gun-shot wound is exposed, should put a Surgeon on his guard against giving a hasty judgment in any case that is not very plain and simple. Military surgery abounds with examples of wounds of such extent and gravity as apparently to warrant the most unfavourable prognosis, which have nevertheless terminated in cure; while others, regarded as proportionably trifling, have led to fatal results. Tables may be found in works showing statistically the nature and relative numbers of wounds and injuries received in various actions, with their immediate and remote consequences, as well as the results of the surgical operations they have led to; but these afford little aid towards the prognosis of particular cases, each of which must be estimated in its own individual circumstances. Such tables are chiefly of value where they afford indications of the effects of different modes of treatment in wounds of a corresponding nature, and then only in patients under like circumstances of age and condition. Even moral circumstances must not be disregarded. The probable issue in any given case will be very different in one soldier, who is supported by the stimulating reflection that he has received his wound in a combat which has been attended with victory, from what it will be in another, who labours under the depression consequent upon the circumstances of defeat.

TREATMENT OF GUN-SHOT WOUNDS IN GENERAL.

When the circumstances of a battle admit of the arrangement, the wounded should receive surgical attention preliminary to their being transported to the regimental or general field hospitals in rear. A slight provisional dressing, a few judicious directions to the bearers, may occasionally prevent the occurrence of fatal hæmorrhage, or avert serious aggravation of the original injury from malposition, shaking, and spasmodic muscular action, in the course of conveyance from the neighbourhood of the scene of conflict to the hospital. In the siege-operations before Sebastopol, this was accomplished by assistant-surgeons in the trenches, or, according to the French system, by regular ambulance-hospitals in the ravines leading to them. The provisional treatment should be of the simplest kind, and chiefly directed to the prevention of additional injury during the passage to the hospital, where complete and accurate examination of the nature of the wound can alone be made, and where the patient can remain at rest after being subjected to the required treatment. The removal of any missiles or foreign bodies which may be readily obvious; the application of a piece of lint to the wound; the arrangement of any available support for a broken limb; protection against dust, cold, or other objectionable circumstances likely to occur in the transit; if 'shock' exist, the administration of a little wine, aromatic ammonia, or other restorative, in water,—need little time in their execution, and may prove of great service to the patient. If hæmorrhage exist from injury to a large vessel, it must of course receive the Surgeon's first and most earnest care. He should not trust to the pressure of a tourniquet, but secure it at once by ligature. Without this safeguard during the transport, and while in the hands of uneducated attendants, the life of the wounded man might be endangered, either from debility consequent upon gradual loss of blood, or from sudden fatal hæmorrhage. It has been recommended by some Surgeons that all attendants whose duties consist in carrying the wounded from a field of battle should be directed, when bleeding is observed, to place a finger in the wound, and keep it there during the transport, until the aid of a Surgeon is obtained. The precise spot where compression by the finger is wanted, and the degree of pressure necessary, will be quickly made manifest to the sight by the effects on the flow of blood. Such a practice seems to offer less objection than the use of tourniquets by men whose knowledge of their proper application must be exceedingly limited.

On arrival at the hospital, where comparative leisure and absence of exposure afford means of careful diagnosis and definitive treatment, the following are the points to be attended to by the Surgeon: firstly, examination of the wound with a view to obtaining a correct knowledge of its nature and extent; secondly, removal of any foreign bodies which may have lodged; thirdly, adjustment of lacerated structures; and, fourthly, the application of the primary dressings.

The diagnosis should be established as early as possible after the arrival at hospital. An examination can then be made with more ease to the patient, and more satisfactorily to the Surgeon, than at a later period. Not only is the sensibility of the parts adjoining the track of the ball numbed, but there is less swelling to interfere with the examination, so that the amount of disturbance effected among the several structures is more obviously apparent.

One of the earliest rules for examining a gun-shot wound is to place the patient, as nearly as can be ascertained, in a position similar to that in which he was, in relation to the missile, at the time of being struck by it. In almost every instance the examination will be facilitated by attention to this precept. Occasionally it will at once indicate the probable injury to vessels or other important structures, in cases where the mutual relations of the wounds of entrance and exit, in the erect or horizontal posture of the body, would lead to no such information. Even in the direct course taken by a rifle-ball in a simple flesh-wound, an erroneous opinion of the line in which the ball has moved may be formed from the first view, in consequence of the ready mobility of the several structures among themselves, and their varying degrees of elasticity. Injury to nerves, inducing paralysis; contusions of blood-vessels, leading to secondary hæmorrhage or gangrene, may thus, without sufficient circumspection, be overlooked on the first admission to hospital.

When only one opening has been made by a ball, it is to be presumed that it is lodged somewhere in the wound, and search must be made for it accordingly. But even where two openings exist, and evidence is afforded that these are the apertures of entrance and exit of one projectile, examination should still be made to detect the presence of foreign bodies. Portions of clothing, and, as has already been shown, other harder substances, are not unfrequently carried into a wound by a ball; and, though it itself may pass out, these may remain behind, either from being diverted from the straight line of the wound, or from becoming caught and impacted in the fibrous tissues through which the ball has passed. The inspection of the garments worn over the part wounded may often serve as a guide in determining whether foreign bodies have entered or not, and if so, their kind, and thus save time and trouble in the examination of the wound itself.

Of all instruments for conducting an examination of a gun-shot wound, the finger of the Surgeon is the most appropriate. By its means the direction of the wound can be ascertained with least disturbance of the several structures through which it takes its course. If bones are fractured, the number, shape, length, position, and degree of looseness of the fragments may be more readily observed. In case of lodgment of foreign bodies, not only is their presence more obvious to the finger direct than through the agency of a probe, or other metallic instrument, but by its means intelligence of their qualities is also communicated. A piece of cloth lying in a wound is recognised at once by a finger; while, saturated with clot, as it is under such circumstances, it would probably be confounded among the other soft parts by any other mode of examination. The index-finger naturally occurs as the most convenient for this employment; but the opening through the skin is sometimes too contracted to admit its entrance, and in this case the substitution of the little finger will usually answer all the purposes intended. When the finger fails to reach sufficiently far, owing to the depth of the wound, the examination is often facilitated by pressing the soft parts from an opposite direction towards the finger-end.

It was formerly the custom to enlarge the external orifice of all gun-shot wounds by incision; and not merely the opening, but the walls of the wound itself, as soon after the injury as possible. This was not done as a means of rendering the examination easier, but as a prophylactic measure. Dilatation was also employed by tents and various other means, with a view to secure the escape of sloughs and discharges. The opinions held by the older Surgeons respecting the nature of these injuries, already briefly adverted to in the historical remarks on the subject, sufficiently explain their object in making incisions, namely, to convert what they regarded as a poisoned into a simple wound, and to obviate tension, and prevent strangulation of neighbouring tissues by tumefaction, on inflammation arising in its track. Even so late as 1792, Baron Percy, in his *Manuel du Chirurgien d'Armée*, writes, "The first indication of cure is to change the nature of the wound as nearly as possible into an incised one." English Surgeons have, however, generally discarded the practice since the arguments urged by John Hunter against it, just about the same date as Baron Percy wrote, excepting only in cases where it is required to allow of the extraction of some extraneous body; to secure a wounded artery; to replace parts in their natural situation, as in protrusion of viscera in wounds of the abdomen; or, "in short, when any thing can be done to the part wounded, after the opening is made, for the present relief of the patient, or the future good arising from it." It does not often happen that it is necessary to enlarge the openings of wounds to remove balls, although a certain amount of constriction of the skin may be expected from the addition of the instrument employed in the extraction; but if much resistance is offered to their passage out, it is better to divide the edges of the fascia and skin to the amount of enlargement required, than to use force. In removing fragments of shells, or detached pieces of bone, the fascia and skin have almost invariably to be divided to a considerable extent.

Where the finger is not sufficiently long to reach the bottom of the wound, even when the soft parts have been approximated by pressure from an opposite direction, and when the lodgment of a projectile is suspected, a long silver probe, that admits of being bent by the hand if required, is the best substitute. Elastic bougies or catheters are apt to become curled among the soft parts, and do not convey to the sense of touch the same amount of information as metallic instruments do. The probe should be employed with great nicety and care, for it may inflict injury on vessels or other structures which have escaped from direct contact with the ball, but have returned, by their elasticity, to the situations from which they had been pushed or drawn aside during its passage. The above directions for examining wounds apply more particularly to such as penetrate the extremities, or extend superficially in other parts of the body; where a missile has entered any of the important cavities, search for it is not to be made, but the Surgeon's attention is to be directed to matters of more vital importance to be hereafter noticed.

As soon as the presence of a ball or other foreign body is ascertained, it should be removed. If it be lying within reach from the wound of entrance, it should be extracted through this opening by means of some of the various instruments devised for the purpose. In case of a leaden bullet, Coxeter's Extractor, corresponding with Baron Percy's instrument for the same purpose, and consisting of a scoop for holding, and central pin for fixing, the bullet, has been found a very convenient appliance, from the comparatively limited space required for its action. Instruments of two blades, or scoops, with ordinary hinge action, dilate the track of the wound injuriously before the ball can be grasped by them. The way to the removal of a bullet may often be smoothed by judiciously clearing away the fibres among which it is lodged, during the examination, by the finger; and sometimes, by means of the finger in the wound, and external pressure of the surrounding parts, the projectile may be brought near to the aperture of entrance, so that its extraction is still further facilitated. Such foreign substances as pieces of cloth can usually be brought out by the finger alone, or by pressing them between the finger and a silver probe inserted for the purpose. Sometimes a long pair of dressing forceps, guided by the finger, is found necessary for effecting this object. Caution must be used in employing forceps where the foreign substance is out of sight, and of such a quality that the soft tissues may be mistaken for it.

In instances where the foreign body has not completely penetrated, but is found lying beneath the skin away from the wound of entrance, an incision must be made for its extraction. Before using the knife, the substance to be removed should be fixed *in situ*, by pressure on the surrounding parts. In the instance of a round ball, the incision should be carried beyond the length of its diameter; an addition of half a diameter is usually sufficient to admit of the easy extraction of the ball. In removing conical balls, slugs, fragments of shells, stones, and other irregularly-shaped bodies, the Surgeon cannot be too guarded in arranging that the fragment is drawn away with its long axis in line with the track of the wound. By proper care in this respect, much injury to adjoining structures may be avoided.

If balls are impacted in bone, as happens in the spongy heads of bones, in bones of the pelvis, and occasionally, though rarely, in other parts of long bones, they should be removed. This can be effected by means of a steel elevator, of convenient size; or, should this fail from the ball being too firmly impacted, a thin layer of the bone on one side of the ball may be gouged away, so that a better purchase may be obtained for the elevator, in effecting its removal. The fact is now fully established that, although in a few isolated cases balls remain lodged in bones without sensible inconvenience, in the majority the lodgment leads to such disease of the bony structure as often to entail troublesome abscesses, and in some instances eventually to necessitate amputation. The lodgment of balls will not often occur without extensive fracture in warfare where rifled arms of such force as the Minié or Enfield are the chief weapons employed, but will not unfrequently be met with in such campaigns as have lately happened in India.

Should there be reason for concluding that a ball or other foreign body has lodged, but after manual examination, and observation as well by varied posture of the part of the body supposed to be implicated as by indications derived from the patient's sensations, effects of pressure or injury to nerves, and all other circumstances which may lead to information, should the site of the lodgment not be ascertained, the search should not be persevered in to the distress of the patient. Neither, although the site of lodgment be ascertained, if extensive incisions are required, or if there is danger of wounding important organs, should the attempts at extraction be continued. Either during the process of suppuration, by some accidental muscular contraction or by gradual approach toward the surface, its escape may be eventually effected; or, if of a favourable form, and if not in contact with nerve, bone, or other important organ, it may become encysted, and remain without causing pain or mischief. When John Hunter wrote on gun-shot wounds, he remarks, the practice of searching after a ball, broken bones, or any other extraneous bodies, had been in a great measure given up, from experience of the little harm caused by them when at rest, and not in a vital part; and he himself advises, even when a ball can be felt beneath skin that is sound, that it should be let alone, chiefly on the ground that two wounds are more objectionable than one, and that the extent of inflamed surface is proportionably increased by incision. More extensive experience has, however, shown, that not only is the risk of subsequent ill results greater in those cases where foreign bodies remain lodged than when they have been cut out, but also that the advantages of a second opening for the escape of the necessary sloughs and discharges greatly preponderate over the disadvantages connected with it, as regards the additional extent of injured surface. The advantage also of the satisfaction to the mind of a patient from whom a ball has been removed must not be overlooked; for men suffering from gun-shot wounds are invariably rendered uneasy by a vague apprehension of danger, for some time after the injury, if the missile has remained undiscovered.

When a gun-shot wound has been accompanied with much laceration and disturbance of the parts involved in the injury, it is necessary, after the removal of all foreign substances that can be detected, to readjust and secure the disjoined structures as nearly as possible in their normal relations to each other. The simplest means—strips of adhesive plaster, light pledgets of moist lint, a linen roller, favourable position of the limb or part of the body wounded—should be adopted for this purpose. Pressure, weight, and warmth should be avoided as much as possible in these applications, consistent with the end in view. It must not be forgotten, in thus bringing the parts together, that the purpose is not to obtain union by adhesion, which cannot be looked for, but simply to prevent avoidable irritation and mal-position of parts, during the subsequent stages of cure by granulation and cicatrisation. In all gun-shot wounds, much discomfort to the patient is prevented by carefully sponging away all blood and clot from the surface adjoining the wound, and by adopting measures to prevent its spreading again in consequence of oozing. This can be readily done with the aid of a little warm water and arrangement when the wound is first dressed, but can only be accomplished with considerable inconvenience after the thin clots have become hard and firmly adherent to the skin.

When the parts of a lacerated gun-shot wound have been brought into apposition, as in simple penetrating wounds, the only dressing necessary is moistened lint. It should be kept moist, either by the renewed application of water dropped upon it, or by preventing evaporation by covering it with oiled silk. The sensations of the patient may be consulted in the selection of either of these, and climate and temperature will be often found to determine the choice. In hot climates cold applications are the more grateful, and by checking the amount of inflammatory action and circumscribing its extent are usually the more advantageous. M. Velpeau, and other French Surgeons, have strongly recommended the use of linseed-meal poultices, above all wet linen applications. Charpie is still extensively employed in French military hospitals.* M. Baudens and Dr. Stromeyer have strongly recommended the topical

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* M. Scrive gives the following as the weight of the linen-dressings consumed by the wounded of the French army in the campaign in the Crimea:

				English weight.			
				tons.	cwt.	qr.	lb.
Linen cloth	101,779	kilogrammes	=	100	2	1	23
Rolled bandages . .	46,446	,,	=	45	13	2	14
Charpie	47,776	,,	=	46	19	3	4

And estimates the following as the proportion consumed by each of the wounded:

					English weight avoirdupois.			
					lb.	oz.	dr.	gr.
Linen cloth	2 kil.	482	grammes	=	5	7	0	10
Rolled bandages . .	0 ,,	891	,,	=	1	15	7	13
Charpie	1 ,,	181	,,	=	2	9	11	0
Total . .	4 ,,	554	,,	=	10	0	2	23

In an Army Medical Department Circular, dated 27th May 1855, it was announced that the Secretary of State for War had decided the following "Field Dressing" should form part of every British soldier's kit on active service, so as to be available at all times and in all places as a first dressing for wounds:

Bandage of fine calico, 4 yds. long, 3 in. wide.
Fine lint, 3 in. wide, 12 in. long.
Folded flat and fastened by 4 pins.

application of ice, placed in bladders; others, the continued irrigation of the wound with tepid water. The means of applying such remedies are rarely available in the military hospitals where gun-shot wounds are ordinarily treated in their early stages. When much local inflammation has set in, and when there is much constitutional fever even without unusual local irritation, the non-evaporating or warm applications will be found to be the most advantageous.

When suppurative action has been fully established, the Surgeon must be guided by the general rules applicable to all other such cases. Care must be taken to prevent the accumulation of pus, lest it burrow, and sinuses become established; not an unfrequent result of want of sufficient caution in this regard. If much tumefaction of muscular tissues beneath fasciæ occurs, or abscesses form in them, free incisions should be at once made for their relief. In wounds where the communication between the apertures of entrance and exit is tolerably direct, occasional syringing with tepid water may be useful, by removing discharges and any fibres of cloth which may be lying in the course of the wound. Weak astringent solutions are occasionally employed in a similar way, with a view to improving the tone of the exhalents and exciting a more vigorous action in the process of granulation. The strictest attention to cleanliness and the complete removal of all foul dressings are essentially necessary, not merely for the comfort of the patient, but to prevent the accumulation of noxious effluvia, and also to obviate the access of flies to the wounds. In tropical climates, and in field-hospitals in mild weather, where many wounded are congregated, flies propagate with wonderful rapidity, and the utmost care is necessary to prevent the deposit of ova and generation of larvæ in the openings of gun-shot wounds, especially while sloughs are in process of separation. Cloths dipped in weak solutions of creasote or disinfecting fluids, laid over the wound, are found necessary for this purpose when the insects abound in great numbers.

The constitutional treatment in an ordinary gun-shot wound, uncomplicated with injury to bone or structures of first importance, should be very simple. The avoidance of all irregularity in habits tending to excite febrile symptoms or to aggravate local inflammation, attention to the due performance of the excretory functions, and support of the general strength, are chiefly to be considered. Bleeding, with a view to prevent the access of inflammation in such cases, is now never practised, as formerly, by English Surgeons. The diet should be nutritious, but not stimulating. A pure fresh atmosphere is a very important ingredient in the means of recovery. If from previous habits of the patient, or from circumstances to which he is unavoidably exposed, the local inflammation has become aggravated,—indicated by pain, increased swelling, and redness about the wound,—topical depletion by leeches or cupping, bleeding from the arm, saline and antimonial medicines, and strict rest in the recumbent position, must be had recourse to, the extent being regulated by the circumstances of each case. In instances such as these, when the inflammation has become diffused, the purulent secretion is not confined to the track of the wound, but is liable to extend among the areolar connexions of the muscles; and if the cure be protracted, attention will be necessary to prevent the formation of sinuses. If stiffness or contractions result, attempts must be made to counteract them by passive motion and friction, with appropriate liniments; if a tendency to œdema, and debility, remain in a limb after the wound is healed, the cold-water douche will be found to be one of the most efficient topical remedies. In French practice, the administration of a chalybeate tincture,* as a tonic, or diluted as an injection, in wounds threatening to assume an unhealthy character, is very highly praised. It is stated, that under the conjoined employment of this remedy internally and externally, in wounds of a pallid unhealthy aspect, accompanied by nervous irritability and symptoms of approaching pyæmia, the granulations have resumed a red and healthy appearance, and the general state of health become rapidly favourable.

Progress of cure. Simple flesh-wounds from gun-shot usually heal in five or six weeks. In the course of the first day the part wounded becomes stiff, slightly swelled, tender, a slight inflammatory blush surrounds the apertures through which the missile has passed, and a slight serous exudation escapes from them. Suppuration commences on the third or fourth day, and in about ten days or a fortnight the sloughs are thrown off. Granulation now progresses, more or less quickly according to the health and vigour of the patient's constitution. The opening of exit is usually the first closed. When the wound is complicated with unfavourable circumstances, whether inducing in the patient a condition of asthenia, or leading to excess of inflammatory action, the progress of the cure may be extended over as many months, as, under favourable circumstances, weeks are occupied in the process.

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* Perchlorure de fer, 30 drops, two or three times daily as a tonic, and diluted with six parts of water as an injection.

GUN-SHOT WOUNDS IN SPECIAL REGIONS OF THE BODY.

The circumstances connected with wounds in particular situations of the body, or in particular organs, are in many respects common to injuries from other causes than gun-shot; and in the following remarks the attention is chiefly drawn only to those leading peculiarities which constantly demand the consideration of the Army Surgeon, and which spring either from the nature of gun-projectiles, or the circumstances under which this branch of military practice has for the most part to be pursued.

Gun-shot Wounds of the Head.

No injuries met with in war require more earnest observation and caution in their treatment than wounds of the head. The vital importance of the brain; the varied symptoms which accompany the injuries to which this organ may be subjected, directly or indirectly; the difficulty in tracing out their exact causes; the many complications which may arise in consequence of them; the sudden changes in condition which not unfrequently occur without any previous warning;—all these circumstances will keep a prudent Surgeon who has charge of such wounds continually on the alert. Injuries of this class, the most slight in appearance at their onset, not unfrequently prove most grave as they proceed, from encephalitis and its consequences, or from plugging of the sinuses by coagula, leading to coma, paralysis, or pyæmia; and the converse sometimes holds good with injuries presenting at first the most threatening aspects, where care is taken to avert these serious results. Much will depend on the part of the head struck, both as regards the thicker and stronger processes or portions of the skull, and the situation of the sinuses and parts of the cerebrum within; on the force and shape of the projectile; the angle at which it strikes; the age and condition of the patient; and other matters already referred to in the general remarks on gun-shot wounds. Mr. Guthrie has laid down as a rule that injuries of the head, of apparently equal extent, are more dangerous on the forehead than on the side or middle portion, and still more so than those on the back part; and that a fracture of the vertex is infinitely less important than one at the base of the cranium. When the injuries are caused by rifle-balls, however, these considerations are rarely of much avail, for the power of injury is such that it can scarcely ever be confined to the immediate neighbourhood of the part directly struck.

Wounds of the head may be divided, for convenience of description, into wounds of the scalp and pericranium, without fracture of bone; similar wounds complicated with fracture of the outer or of both tables, without pressure on the encephalon; wounds with fracture and depression; and lastly, wounds in which the encephalon itself has been penetrated. Severe contusion of the bones of the cranium, followed by necrosis, and even fracture, with or without depression, may occur without an open wound of the superficial investments. The case of an officer is mentioned in Dr. Macleod's *Notes of the Crimean War*, who was thus killed by a round shot. The scalp was not cut, almost uninjured, but the skull was most extensively comminuted.

Wounds of the scalp and pericranium. These wounds are usually inflicted by projectiles which are brought into contact at a very acute angle, so that little direct injury to the brain or its membranes is inflicted, and the Surgeon's attention need only be directed to the same considerations as must occur in any contused wounds of the scalp from other causes than gun-shot. But even in these accidents, though appearing to be simple flesh-wounds, serious cerebral concussion, and other lesions, are occasionally met with. The usual stupor and other signs of concussion may be very evanescent, or may last for several days, disappearing gradually and wholly, or entailing subsequent evils at more or less remote periods. It must not be forgotten that when the pericranium is removed by a musket-ball, however superficial the injury may seem, there is always a certain degree of injury and bruising to the bone from which it is torn, and necessary laceration of the vessels which inosculate with the nutritive capillaries of the diploë, and through them of the vessels of the meninges with which they are connected. The injury to this vascular system almost invariably leads to necrosis of the portion of the skull from which the coverings are carried away; and sometimes, even when the pericranium is not torn off, sufficient injury is inflicted to lead to a like result. The death of bone is generally limited to a thin layer of the outer table, which in due time exfoliates. The injury to the vessels ramifying between the inner surface of the cranium and dura mater may lead to serious results. There may be rupture of a sinus leading to compression, or fatal results may ensue from inflammation and suppuration. The case of a young soldier in whom the longitudinal sinus was thus ruptured occurred to the writer. In this instance a rifle-ball had divided the scalp and pericranium about four inches in length obliquely across the skull, just anterior to the angle of the lambdoidal suture, the posterior end of the sagittal suture being exposed midway in the line of the wound. The patient vomited at the instant of the blow, and symptoms of compression, mixed with some of concussion, soon followed. He died eleven hours after the injury. At a post-mortem examination, the superior longitudinal sinus was found to be ruptured, and about four ounces of coagulated blood were lying on the brain. Two darkly-congested spots were observed in the cerebrum, one on each hemisphere, corresponding with the line of direction in which the ball had passed, and these, when cut into, presented the usual characters of ecchymoses. There was no fracture of bone. The case may be found detailed at some length in the *Lancet*, vol. i. 1855. When inflammation follows the passage of a ball, whether terminating in resolution or leading to abscess, the symptoms and treatment required will be the same as in similar affections from other causes. In like manner, the occurrence of erysipelas, or other complications to which these wounds of the scalp are liable, will be found treated elsewhere. (See INJURIES OF THE HEAD.)

The treatment of an ordinary gun-shot wound of the scalp should be very simple. Cleansing the surface of the wound, removing the hair from its neighbourhood for the easier application of dressings, lint moistened with clean water, very spare diet, and careful regulation of the excretions, are the only requirements in most cases. The patient must be closely watched, so that measures may be taken to counteract inflammatory symptoms in their earliest stages. Even after one of these wounds has healed, and the patient to all appearance has quite recovered, it is necessary to enjoin continued abstinence from excesses of all kinds. Instances are frequently quoted where intoxication, a long time after the date of injury, has induced symptoms of apoplexy and death. In the *Surgical History of the Crimean Campaign*, the case of a soldier of the 31st Regiment, thirty-eight years old, who received a contused wound at the back of the head from a piece of shell, without section of the scalp and without lesion of the bone, is related. In this instance a small abscess formed under the scalp and was evacuated. After the wound was healed, the man suffered from constant headaches, and was invalided to England. Soon after landing, he drank freely, coma followed, and he died shortly afterwards. The post-mortem examination showed traces of inflammatory action in the dura mater, and "just anterior and superior to the corpora quadrigemina was a tumour the size of a walnut, composed of organised fibrin and some clotted blood."

Wounds complicated with fracture, but without depression on the cerebrum. These are very uncertain in their effects, and often apt to mislead the Surgeon, from the absence of urgent symptoms in their early stages. The occurrence of fracture is, however, sufficient to show the force with which the projectile has struck the head, and to indicate the mischief which the brain and its immediate coverings have not improbably sustained.

In these injuries there may be a simple furrowing of the outer table, without injury to the inner; or there may be fissure extending to a greater or less degree of length, or radiating in several lines; or both tables may be comminuted in the direction the ball has traversed in such small portions that they lie loosely on the dura mater without much alteration in the general outline of the cranial curve. The chief and only means in many cases of concluding that no depression upon the cerebrum has taken place is the absence of the usual symptoms of compression; for it is well known that simple observation of the injury to the outer table, whether by sight or touch, will by no means necessarily lead to a knowledge of the amount of injury, or change of position, in the inner table.

When simple removal of a portion of the outer surface of the skull has been caused by the passage of the ball or other missile, the wound will sometimes heal, under judicious treatment, without any untoward symptom. A layer of the exposed surface of bone will probably exfoliate, and the wound granulate and become closed without further trouble. But such injuries, for reasons before named, are very likely to be followed by inflammation, and not improbably abscess, between the internal table and dura mater; and further, as a consequence of the vascular supply being stopped, and perhaps also partly from the effects of the original contusion by necrosis of the inner table itself. Care must be taken not to mistake one of these injuries for a depressed fracture, as is not unlikely to happen when the excavation effected by the projectile is rather deep, and the edges of the bone bordering the excavation are sharp.

Fissured fractures, when the fissure extends through the skull, usually result from injuries by shell. The passage of a ball may fracture and very slightly depress a portion of the outer table of the cranium, and then the line of fracture will very closely simulate fissured fracture extending through both tables, and the diagnosis between them be excessively doubtful. When fissured fracture exists, the distance to which it may be prolonged is often quite unindicated by symptoms, and its extent is very uncertain. Fissures often extend to long distances. They may occur at a part remote from the spot directly injured. In the case of a lieutenant of the 11th Hussars, who was apparently slightly wounded at Balaklava in the middle of the forehead by a piece of shell, a fissured fracture was found after death across the base of the skull, quite unconnected with the primary wound, and seemingly from *contre-coup*. Death resulted from inflammation and suppuration set up near this indirectly injured part. Fissured fracture of the inner table may also occur from the action of a ball without external evidence of the fracture. Such a case occurred in the 55th Regiment in the Crimea. The soldier had a wound of the scalp along the upper edge of the right parietal bone. The ball in passing had denuded the bone; but there was no depression. The man walked to camp from the trenches without assistance, and there were no cerebral symptoms on his arrival at hospital; but five days afterwards there was general œdema of the scalp and right side of face, the wound became unhealthy, and slight paralysis appeared on the left side. The next day hemiplegia was more marked, convulsion and coma followed, and he died on the thirteenth day after the injury. Pressure from a large clot of coagulum, and extensive inflammatory action, were the immediate causes of death; but a fissure, confined to the inner table, running in line with the course of the ball, was also discovered. A preparation of the calvarium in this case was presented by Dr. Cowan, 55th Regiment, to the Museum at Fort Pitt.

The cases where comminution has resulted from the track of a ball across the skull, generally present less unfavourable results than those where a single fissured fracture, extending through both tables, exists. The small loose fragments can be removed; and if the dura mater be intact, the case, with proper care to prevent inflammatory action, may not improbably be attended with a favourable recovery.

Wounds complicated with fracture, and depression on the cerebrum. Such wounds are most serious, and the prognosis must be very unfavourable. They must not be judged of by comparison with cases of fracture with depression caused by such injuries as are usually met with in civil practice. The severe concussion of the whole osseous sphere by the stroke of the projectile, the bruising and injury to the bony texture immediately surrounding the spot against which it has directly impinged, as well as the contusion of the external soft parts, so that the wound cannot close by the adhesive process, constitute very important differences between gun-shot injuries on the one side, and others caused by instruments impelled solely by muscular force on the other. So also the injury to the brain within, and its investments, is proportionably greater in such injuries from gun-shot. The experience of the Crimean campaign shows, that when these injuries occurred in a severe form, they invariably proved fatal. Of seventy-six cases treated, where depression only, without penetration or perforation, existed, fifty-five proved fatal, twelve were invalided, and nine only were discharged to duty. In the twenty-one survivors, the amount of depression is stated in the history of the campaign to have been slight, though unmistakable; and all except one recovered without any bad symptom. Of eighty-six other cases where perforation or penetration of the cranium occurred, all died.

With penetration of the cerebrum. It is obvious, that where a projectile has power not only to fracture, but also to penetrate, the cranium, it will rarely be arrested in its progress near the wound of entrance. Either splinters of bone, or the ball, or a portion of it, will be carried through the membranes into the cerebral mass. Sometimes a ball, if not making its exit by a second opening in the cranium, will lodge at the point of the cerebral substance opposite to that of its place of entrance, but the course a projectile may follow within the cranium is very uncertain.

Instances have occurred where balls have lodged in the cerebrum, without giving rise to serious symptoms of danger for a long time. Such cases might lead to throwing Surgeons off their guard in making a prognosis, from supposition that the ball by some accident had not lodged. The case of a soldier wounded by a ball in the posterior part of the side of the head is mentioned by Mr. Guthrie. The wound healed, and the man returned to duty; a year afterwards he got drunk, and died suddenly. The ball was found in a sac, lying in the corpus callosum. Another soldier wounded at Waterloo had a similar recovery, and also died after intoxication. The ball was found deeply lodged in a cyst in the posterior part of the brain. An artillery soldier was wounded in the Crimea by a rifle-ball, which entered near the inner angle of the left superciliary ridge. The wound progressed without a bad symptom, until a month afterwards, when coma came on, and death shortly followed. The ball was found in a sac, in which pus also was contained, at the base of the left anterior lobe of the brain.

Treatment. The treatment of the various kinds of fractures from gun-shot, and their complications, may be considered together. Formerly, a gun-shot wound of the head was supposed to be in itself a sufficient indication for the use of the trephine; indeed, even where no fracture was caused, an opening was recommended by comparatively recent Surgeons to be made in the cranium, to meet symptoms which might be expected to result. Modern Surgeons, however, generally have made use of the trephine only when there was reason for concluding that depressed bone was leading to *permanent* interruption of cerebral function, or that an abscess had formed within reach, and was capable of evacuation. Preventive trephining has been proved to be useless, as well as dangerous, and is no longer an admissible operation. The tendency of the most recent experience has been to limit the practice of trephining to the narrowest sphere; and when the very great difficulty of making accurate diagnosis in these cases is considered,—whether as to the distinguishing signs of compression; the precise seat of its cause, if the compression exist; the space over which this cause, when ascertained, may extend; its persistent or temporary character; its complications; and certain dangers connected with the operation itself, —no wonder need be excited that this tendency should exist. Besides, the numerous cases which have now been noted where bone has evidently been depressed, but the brain has accommodated itself to the pressure without serious disability being caused, or where compression from effusion has been removed by absorption under proper constitutional treatment, are farther causes of hesitation in respect to trephining. In the *Surgical Report of the Crimean Campaign*, it is stated that the trephine was only successfully applied in four cases (and none of these were from rifle-balls) during the whole war; and that in these instances the patients were subsequently subject to occasional headache and vertigo; and in the French report, by Dr. Scrive, it is stated that trephining was for the most part fatal in its results in the French army. In siege-operations, the experience as regards wounds of the head is always very extensive, the lower parts of the body being so much more protected in the trenches. According to Dr. Scrive's returns, one of every three men killed in the trenches before Sebastopol, and one in every 3·4 wounded, was injured in this region. In the English returns, wounds of the head and face in the men are shown as 19·3 per cent; in the officers, as 15 per cent; but this is of the total wounded in the field as well as in the trenches. There was, therefore, as extensive a range for observation of the effects of trephining in the siege of Sebastopol as is likely to happen in any war. Dr. Stromeyer, who in the early part of his professional career resorted to trephining in complicated fractures of the skull, records in his *Principles of Military Surgery*, that he has abandoned the practice. After the battle of Kolding, in Schleswig, in 1849, there were eight gun-shot fractures of the skull, with depression, and more or less cerebral symptoms. In all these, with one exception, the detachment of the fractures was left to nature, and all recovered. One patient, from whom some fragments were removed on the seventh day, was placed in considerable danger by the treatment, and Dr. Stromeyer resolved never to adopt it again. In 1850, in Schleswig, two young Surgeons came under Dr. Stromeyer's care with gun-shot wounds of the head, accompanied by deep depression; they were both treated without trephining, and both recovered. Throughout the three campaigns of the Schleswig-Holstein war, there was only one case of trephining which gave a favourable result. Military experience makes it difficult to understand the frequent and successful performance of trepanning by the older Surgeons for such slight causes as they performed it, excepting that the patients laboured under little else than the effects of the operation itself, while very fatal mischief has existed in addition in those instances in which the operation has been resorted to for accidents from gun-shot. A circumstance quoted by Sir G. Ballinghall particularly illustrates the favourable results of abstaining from trephining in some cases. After the battle of Talavera, a hospital which had been established in the town had to be suddenly abandoned, and an order was given for all the wounded who could march to leave it. There was no time for selection, and among those who marched were twelve or fourteen men with wounds of the head, in which the cranium was implicated, four or five having both tables fractured, and two having the globe of one eye destroyed along with fracture of the os frontis. All these men recovered, though they were sixteen days on the march, harassed and exposed to a burning sun, and had no other application than water-dressing. Of eight cases of contusion or fracture of the cranium, with displacement of both tables, recorded by Dr. Williamson, among men who were sent from India to Chatham, during the late mutiny, none had been trephined. In all these there was a depressed cicatrix, the wound having contracted and become closed by a strong fibrous investment. In one case,—a wound by a musket-ball, in the centre of the forehead,—the ball was supposed to be still lodged within the skull. In the Fort Pitt

Museum are several preparations, showing depressed fracture of the inner table of the skull from gun-shot, taken from patients who had recovered without trephining, and died years afterwards from other causes. The edges of the depressed portions of bone had become smooth, and united by new osseous matter, and the cerebrum must have accommodated itself to the new form of the inner cranial surface. Two or three instances are known in which the course of a ball has been traced from the site of entrance across the brain, and trephining resorted to for its extraction with success; but there are also many others in which the mere operation of the extraction of a foreign body has apparently led to the immediate occurrence of fatal results. Moreover, splinters of bone are not unfrequently carried into the brain by balls, and these may elude observation; or the ball itself may be divided and enter the brain in different directions, as was observed in the Crimea; when the operation of trephining can only be an additional complication to the original injury, without any probable advantage. Where irregular edges, points, or pieces of bone, are forced down and penetrate—not merely press upon—the cerebral substance, or where abscess manifestly exists in any known site, or a foreign substance has lodged near the surface, and relief cannot be afforded by the wound, trephining may be resorted to for the purpose ; but the application of the operation, even in these cases, will be very much limited if certainty of diagnosis be insisted upon. In all other cases, it seems now generally admitted, that much harm will be avoided, and benefit more probably effected, by employing long-continued constitutional treatment, viz. all the means necessary for controlling and preventing the diffusion of inflammation over the surface of the brain and its membranes,—the most careful regimen, very spare diet, strict rest, calomel and antimonials, occasional purgatives, cold application locally, so applied as to exclude the air from the wound, and free depletion by venesection, in case of inflammatory symptoms arising. Similar remarks will apply in case of lodgment of a projectile within the brain ; if the site of its lodgment is obvious, it should be removed with as little disturbance as possible, but trephining for its extraction on simple inference is unwarrantable.

GUN-SHOT WOUNDS OF THE SPINE.

Gun-shot wounds of the spine are closely associated with similar injuries of the head. In both classes, corresponding considerations must be entertained by the Surgeon in reference to the important nerve-structures, with their membranes, which are likely to be involved in the injury to their osseous envelope; in both, the effects of concussion, compression, laceration of substance, or subsequent inflammatory action, chiefly attract attention. In the *Surgical History of the Crimean Campaign*, twenty-seven cases are noted in which vertebræ were fractured, eight being without apparent lesion of the spinal cord, and nineteen with evident lesion. Of these, twenty-five died; and two, in which the fractures were confined to the processes of the vertebræ, survived to be invalided. The gun-shot wounds affecting the spinal column have not been separated from injuries in other regions in the French returns. Six men only wounded in the spine, during the late mutiny in India, arrived in Chatham. In all, they were the results of musket-balls. Two were wounds of the sacrum; in the remainder, the portions of the vertebræ fractured were the spinous processes. Concussion of the spinal column, leading to paralysis more or less persistent, is usually occasioned by fragments of shell, or stones from parapets; and in these cases the accidents are mostly accompanied by extensive lesions of the neighbouring structures. In one fatal case in the Crimea, the ball passed through the spine rather below the first dorsal vertebra, leading to complete loss of sensation and voluntary motion below the seat of injury, and death on the sixteenth day afterwards; in another, a rifle-bullet entered the right side of the second lumbar vertebra, traversed the spinal canal at that part, and lodged in the body of the bone. In this latter case, violent pain was complained of in the lower extremities, shooting along the groins. The patient was paraplegic, and death ensued thirty-three hours after admission. In another fatal case, a rifle-bullet passed through the right cheek, and lodged near the base of the skull. There was no paralysis, but delirium and coma supervened, and the patient died five days after receiving the wound. The bullet was found after death, lying just below the basilar process, and a large piece of the atlas was broken off and almost detached. The spinal cord did not appear to have been primarily injured; but acute inflammation had been set up, and had extended to the membranes of the brain. There is a preparation in the Museum at Fort Pitt, which shows fracture both of the atlas and axis, without lodgment of the ball. The patient survived thirty days. It is curious that, in a case under the care of the writer, before referred to, where a rifle-ball passed through the right loin, entered the spinal canal between the third and fourth lumbar vertebræ, breaking the laminæ, passed upwards within the column, between it and the cord, and made its exit through the left intervertebral foramen between the second and third vertebræ, as shown after death, no paralysis occurred at the time of the injury, nor subsequently, nor was any evidence afforded post mortem of thecal inflammation having been excited (see *Guy's Reports*, vol. v. 1859).

In injuries of the vertebral column and spinal cord occurring in military practice, the mischief is usually so complicated and extensive, and the medulla itself so bruised, that the cases must be very rare indeed in which the operation of trephining, if justifiable in any case, can offer the slightest prospect of benefit. M. Baudens extracted with an elevator, supplied with a canula, a ball which had lodged in the eleventh dorsal vertebra, and was causing compression with complete paraplegia. The paralysis disappeared immediately after the extraction of the bullet; but tetanus came on four days afterwards, and proved speedily fatal. Balls have been known to pass through the bodies of vertebræ, and apparent cure follow; but as such patients in military practice are usually invalided out of the service as soon as they are fit to leave hospital, no opportunity is afforded of observing the consequences which ulteriorly ensue.

Gun-shot Wounds of the Face.

Wounds of the face from musket-shot, grape, and small fragments of shell are usually more distressing from the deformity they occasion than dangerous to life. The absence of vital organs, the natural divisions among the bones, and their comparatively soft structure, rendering them less liable to extensive splitting; the copious vascular reticulation and supply rendering necrosis so much less likely, and repair so much easier than in other bones; the limited amount of space occupied by the osseous structure between their respective periosteal investments, and the opportunities from the number of cavities and passages connected with this region for the escape of discharges,—lead to this result. On the other hand, the vascularity of this region leads to danger both of primary, and especially secondary, hæmorrhage,—a circumstance which in all deep wounds of this region must be looked for as a not improbable complication. The other complications of these gun-shot wounds are lesions of the organs of special sense, injury to the base of the skull, paralysis from injury to nerves, wounds of glands, their ducts, and of the lacrymal apparatus; but it is scarcely necessary to do more than allude to them, as the considerations connected with their treatment will be found elsewhere.

Wounds from cannon-shot occasionally illustrate what terrible injuries may be borne in this region without life being at once extinguished. They are the more distressing because the patient lives conscious of his sufferings without possibility of surgical alleviation. The case of an officer of Zouaves, wounded in the Crimea, is recorded, who had his whole face and lower jaw carried away by a ball, the eyes and tongue included, so that there remained only the cranium, supported by the spine and neck. This unfortunate being lived twenty hours after the injury, breathing by the laryngeal opening at the pharynx, while his gestures left no doubt that he was conscious of his condition. Mr. Guthrie has recorded a similar case which occurred in an officer during the assault of Badajos. This patient suffered distressingly from want of water to moisten his throat, but could not swallow when some was brought. One eye was left hanging in the orbit, the floor of which was destroyed, and this enabled him to write thanks for attention paid him. He did not die till the second night after the injury.

In the treatment of gun-shot wounds of the face where the bones are splintered and torn, the Surgeon should always retain and replace as many of the broken portions as possible. It is often surprising how small connexions with neighbouring soft parts will suffice to maintain vitality, and lead to restored union in this region. A case which occurred to the writer in August 1855, in a private of the 19th Regiment, is detailed in the *Lancet*, p. 436, of that year. The wound was caused by a fragment of shell. The right half of the arch of the palate was jammed in and fixed at right angles to the other half, and the upper maxillary bone was so comminuted that it was scarcely possible to note the directions of the lines of fracture. The lower maxilla was broken in three places, and there was extensive laceration of the soft parts. Great difficulty was met with at first in unlocking the parts of the palate which had been driven into each other, and when they were separated the right half hung down loosely in the mouth; yet favourable union was obtained between all these fractures, the broken portions being adjusted so that the man recovered with both the upper and lower maxillæ consolidated in their normal relations to each other. No teeth had been driven out of their sockets, and they were very useful as points of support in the steps taken to procure coaptation of the disunited fragments. In the *Lancet* of February 24th, 1855, may be found the description of a series of wounds of the face from the Crimea which were examined by Mr. Samuel Solly, and described by him, some of them illustrating how wonderfully the larger arteries often escape in these injuries. In one, loss of the sense of taste on one side of the tongue had resulted; in two, there was partial paralysis of the portio dura; in another, impaired action of the jaw. In one, where a ball entered at the junction of the malar bone and os frontis on the left side, and descended and escaped at the posterior border of the sterno-mastoid muscle, the sight of the left eye was destroyed, and that of the right weakened; and constant headache, dullness of intellect, and incapacity for mental application remained. The injury had originally been followed by symptoms of cerebral concussion. In another case the man came home with an iron shot firmly wedged and lodged in the centre of the vomer. When extracted at Chatham by Staff-Surgeon Parry, it was found to weigh nearly four ounces. The returns of the Crimean campaign, from the 1st of April 1855 to the end of the war, show 533 wounds of the face, of which number 445 returned to duty, 74 were invalided, and 14 died. Bones were penetrated in 107 of these cases; one eye was injured in 42, and both eyes in 2 cases. Mr. Guthrie has recorded that he several times saw both eyes destroyed by one ball, without much other mischief; and one, and even both, rendered amaurotic by balls which had passed behind the eyes. Of 21 cases of wounds of the face, with injuries to bones, returned to England from the late Indian mutiny, and recorded by Dr. Williamson, 11 had lost the sight of one eye, and 1 of both eyes; 6 cases were complicated with fracture of the lower jaw, and in 3 of these the fracture remained ununited.

GUN-SHOT WOUNDS OF THE CHEST.

These always form a large proportion of the injuries from warfare, both in the open field and more especially in sieges, where the upper part of the body is chiefly exposed. Dr. Scrive's returns show that the proportion of chest to other wounds was 1 in 12 in the trenches, and 1 in 20 in ordinary engagements. In the British forces they are returned as 1 in 10 among the officers during the whole war, and nearly 1 in 17 among the men, from 1st April 1855 to the end of the war. The ample space of this region, and the exposed surface it offers as a target towards the enemy, would lead to an anticipation of such results. The serious complications which ensue when the cavity of the chest is penetrated, and the dangerous consequences of wounds of its viscera, cause the proportionate mortality to be very great. The British returns show that among the officers treated for these wounds $31\frac{1}{2}$ per cent, and among the men $28\frac{1}{10}$ per cent, died. Out of 603 wounded men who returned to England from the late Indian mutiny, the number who had received wounds of the chest was only 19. In many instances men thus wounded do not live long enough to come under treatment, but die on the field of action from penetration of the heart, hæmorrhage, suffocation, or shock; and the proportion of chest-wounds returned as "killed in action," or as "died under treatment," will constantly vary according to circumstances connected with the nature of the military operations, and the opportunities of early removal from the field to hospital.

Gun-shot wounds of the chest may conveniently be divided for study into two classes, viz. *non-penetrating* and *penetrating*. NON-PENETRATING wounds become subdivided into simple contused wounds of the soft parietes; contused and lacerated wounds; the same accompanied with injury to bones or cartilage; and lastly, those complicated with lesion of some of the contents of the chest, the pleura remaining unopened, or, if opened, without a superficial wound. PENETRATING wounds may exist without wound, or with wounds, of one or more of the viscera of this cavity. Among the more serious complications with which the latter may be accompanied is the lodgment of the projectile, or other foreign bodies, as of fragments of bone, within the chest. As wounds of the heart and great vessels are almost invariably at once fatal, and as the organs of respiration occupy the greater part of the cavity of this region, it is in reference to the latter that the treatment of chest-wounds is chiefly concerned.

Non-penetrating wounds. Of the simpler wounds in which the soft parietes only are involved little need be observed, excepting that the healing process is often prolonged by the natural movements of the ribs to which the wounded structures are attached, especially when the ball has taken a circuitous course beneath the skin, and that the Surgeon must be on his guard to watch for pleuritis arising as an occasional consequence of these injuries. In two deaths recorded in the *Director-General's History of the Crimean War*, under simple flesh-wounds, without fracture or pleural opening, from bullets, the fatal termination arose from pleuro-pneumonia. When the force has been great, as when fragments of shell or rifle-balls strike at full speed against a man's breast-plate, not only may troublesome superficial abscesses and sinuses follow, but the lungs may have been compressed and ecchymosed at the time of the injury, and hæmoptysis be one of the symptoms presented.

When the projectile has been of large size, although no opening of the parietes or fracture exists, death sometimes ensues by suffocation as the direct result of pulmonary engorgement. The danger of pleuritis or pneumonia will be greater when the injury has been so severe as to cause division of bone or cartilage, and the subsequent suppuration and process of exfoliation will not unfrequently prove very tedious and troublesome. Although the pleura has not been opened, the lung may be lacerated, either by the force of contusion, or, as in a case recorded by Dr. Macleod, by the edges of the fractured ribs, which may afterwards return to their normal relative positions, so as to leave no indication during life of the means by which the lung had been wounded. Such an injury would be rendered much more probable by the existence of old adhesions, connecting the pulmonary and costal pleuræ opposite to the site of injury.

Notwithstanding a projectile has not penetrated the parietes of the chest, a pleural cavity may be opened, as in injuries from other causes, and the lung wounded by the sharp edges of fractured ribs. This will be indicated by emphysema, pneumo-thorax, hæmoptysis, probably signs of internal hæmorrhage and inflammation. Such wounds will generally be the result of injuries from fragments of shell.

Penetrating wounds. These wounds, especially when the lung is perforated or the projectile lodges, are necessarily exceedingly dangerous. Fatal consequences are to be feared, either from hæmorrhage, leading to exhaustion or suffocation; from inflammation of the pulmonary structure or pleuræ; from irritative fever accompanying profuse discharges; or from fluid accumulations in one or both of the pleural sacs.

In gun-shot injuries a penetrating wound of the chest is in most instances readily obvious to the sense of sight or touch; but it will be found by no means easy always to decide whether a lung has been penetrated or otherwise. The train of symptoms usually described as characterising wounds of the lung must not be expected to be all constantly present; they are each liable to be modified by a great variety of circumstances, and may each severally exist in penetrating wounds of the chest where the lung has escaped perforation. Nor is it always easy to determine whether the ball has lodged or not; or, the ball having passed through, whether fragments of bone, or other substances, have remained behind.

When the chest has been opened by a projectile, the following signs may be expected in addition to the external physical evidences of the injury: a certain amount of constitutional shock; collapse from loss of blood; and, if the lung be wounded, effusion into the pleural cavity, hæmoptysis, dyspnœa, and an exsanguine appearance. These will generally, but not invariably, be followed, after twenty-four hours or later, by the usual signs of inflammation in some of the structures injured.

The shock of penetrating wounds of the chest, apart from the collapse consequent on hæmorrhage, is not generally so great as happens in extensive injuries to the extremities or in penetrating wounds of the abdomen. There is often much more 'shock' when a ball has not penetrated; but, having met with something to oppose its course, has nevertheless inflicted a violent percussion of the whole chest and its contents.

When loss of blood occurs without the lung being wounded, the hæmorrhage is probably proceeding from a wound of one of the intercostal arteries, which has been torn by the sharp ends of fractured bone. Serious hæmorrhage, however, is exceedingly rare from vessels external to the cavity of the chest.

When blood is effused in any large quantity into the pleural sac,—as indicated by the exsanguine appearance of the patient, increasing dyspnœa, occasional hæmoptysis, and the stethoscopic signs on auscultation,—the inference is, that the lung has been opened, and that it is from its structure the blood is flowing. The amount of hæmorrhage in wounds of the lungs will greatly vary according to the direction of the track of the ball; for the large vessels cannot here glide away from the action of the projectile, as they may in the neck or extremities of the body. Wounds, therefore, near the root of each lung, where the pulmonary arteries and veins are largest, are attended with the greatest amount of hæmorrhage; and as coagula can hardly form sufficiently to suppress the flow of blood, are generally fatal.

Hæmoptysis indicates injury to the lung, but does not give assurance that this organ has been penetrated. It generally accompanies gun-shot wounds of the lung in a greater or less degree, no doubt always when a bronchial tube of large size is penetrated; but, as may be ascertained by careful perusal of recorded cases, is sometimes wholly absent, even though the patient may be troubled by cough. Dr. Fraser, in a recent monograph on *Wounds of the Chest*, states that out of nine fatal cases observed by him in the Crimea in which the lungs were wounded, only one had hæmoptysis; and out of seven in which the lungs were found not to be wounded, two had hæmoptysis. This, however, from the writer's observation, would appear to be an unusual proportion of cases in which hæmoptysis was not present after wounds of the lungs.

Dyspnœa is a frequent accompaniment of wounds penetrating the lung, but not a constant symptom before inflammatory action has set in. When dyspnœa is great in the early period, it will often be found to depend upon the injuries to the parietes, and to the pain caused on taking a full inspiration; as a sign of subsequent mischief in the progress of the case, it is, of course, very constantly present. It is now known that the opening of the pleura does not necessarily induce collapse of the lung, even though unfettered by adhesions, during life. It was formerly supposed that the escape of air by the wound was a sufficient proof that the lung had been opened by the projectile; but it is evident that it is not so, as the air may enter by the wound and be forced out again by the expansion of the lung in inspiration, or by the action of the chest on expiration. If air and frothy mucus with blood, as noticed in one of the cases recorded in the Crimean campaign, escape by the wound, there can be no doubt of the nature of the injury. Emphysema is not common in penetrating gun-shot wounds, but occasionally happens. The free opening generally made by the projectile sufficiently explains this fact.

It is not necessary to refer at any length in this place to the inflammations which may supervene. Diffused inflammation of the lung after wounds is not so common as might perhaps be expected. In unfavourable cases, the pleural cavity is generally found to be the seat of extensive inflammatory action, or unhealthy accumulations, especially where irritation has been kept up by the presence of foreign bodies, or the patient's constitution has become from any cause debilitated.

Treatment. The object of the Surgeon's care must be in the first place to arrest hæmorrhage; afterwards to remove pieces, or jagged projections, of bone, or any other sources of local irritation; and to adopt means to prevent interference with the natural process of cure, which takes place by adhesion of the opposite pleural surfaces near the wound in the first instance, and subsequently by cicatrisation of the wound itself, or, as shown in an interesting preparation in the Museum of the Army Medical Department at Fort Pitt, by contraction into a narrow sinus lined with a distinct adventitious membrane into which the small bronchial tubes open. Although the shock may happen to be considerable, attempts to rally the patient, if any be made, should be conducted very cautiously; the prolongation of the depressed condition may be valuable in enabling the injured structures to assume the necessary state for preventing hæmorrhage. Hæmorrhage from vessels belonging to the costal parietes should be arrested by ligature, as in other parts, if the source from which it proceeds can be ascertained, and if the flow of blood be so free as not to be controlled by the ordinary styptics. Operative interference of this kind is chiefly called for on account of secondary, not primary, hæmorrhage. Hæmorrhage from the lung itself must be treated on the general principles adopted in all such cases; the application of cold to the chest, perfect quiet, the administration of opium, and, if the patient be sufficiently strong, bleeding from a large opening until syncope supervenes. When blood has accumulated in any large quantity, and the patient is much oppressed, the wound should be enlarged, if necessary, so as, with the assistance of proper position, to facilitate its escape. If the effused blood, from the situation of the wound, cannot be thus evacuated, and the patient be in danger of suffocation, then the performance of paracentesis, as directed for the relief of empyema, must be resorted to.

The extensive bleedings formerly recommended in all penetrating gun-shot wounds of the chest are now practised with much greater limitations; indeed, should never be employed simply with a view to prevent mischief from arising. Venesection carried to a great extent does harm by lessening the restorative powers of the frame. It appears to interrupt the process of adhesion between the pleural surfaces and the steps taken by nature to repair the existing mischief, while it leads the injured structures into a condition favourable for gangrene, or encourages the formation of ill-conditioned purulent effusions. When inflammation has arisen, venesection may be joined with other means to control its excessive action, and to give relief, which it certainly does, to the patient; and where hæmorrhage is manifestly going on internally, it may be practised with a view of draining the blood from the system and more speedily inducing faintness, to give an opportunity to the pulmonic vessels to become closed; but, even when thus applied, the general state of the patient will not be unconsidered by a judicious Surgeon, nor caution neglected lest the venesection cause him to sink more rapidly from the additional shock to the system and abstraction of restorative force. Taking away blood certainly does not prevent pneumonia from supervening, but occasionally seems to give the inflammation, when it arises, more power over the weakened structures, or even to cause it to be accompanied with typhoid symptoms. Many cases will be found in the various published records derived from the Crimean campaign, where favourable recovery has taken place after wounds of the lung without venesection being at all resorted to as part of the treatment.

The case of an officer of the 19th Regiment, who was shot at the assault of the Great Redan, and under the care of the writer, will serve to illustrate some of the points before named. In this instance, a rifle-ball passed through the upper part of the left scapula near its superior posterior angle, comminuting the bone and entering the chest. The ball, together with a piece of cloth, was excised in front, two inches above and internal to the fold of the axilla. The mouth was filled with blood immediately after the injury; bloody expectoration continued for three days; there was hacking cough on increased inspiration; the respiratory murmur was accompanied with slight crepitating *râles* in the upper part of the lung; there was weakness, but not much 'shock.' The small degree of the latter symptom, and the absence of evidence of effusion of blood into the pleural cavity, led at the time to a suspicion that the ball had glanced round the costal pleura and had only contused the lung; but the fact of the absence of vessels of large size at this part of the lung, especially if there were pleural adhesions, may have been the cause of these results. This officer had been much weakened in frame by scorbutic diarrhœa in the winter of 1854-55, and though the cure was protracted by occasional attacks of diarrhœa subsequently to the injury, by profuse discharge from the wounds, and separation from time to time of spiculæ of bone, he left for England two months afterwards with his recovery nearly completed, and no inconvenience has been experienced in the discharge of his duties since. No venesection was practised in this case; but tonics, nourishing diet, and port-wine were given as soon as suppurative action had been established.

But in discountenancing great bleeding, mention should not at the same time be omitted, that, in many cases, recorded by numerous authors, and judging *post factum*, the successful issues appear to have been owing to copious venesection. A remarkable case occurred in a young soldier of the 33d Regiment, private Thomas Monaghan, under the care of Deputy Inspector-General Dr. Muir, then Surgeon of the regiment. This man was wounded in August 1855, through the left shoulder-joint and chest, the glenoid cavity and head of the humerus being injured, and the lung implicated. In this instance complete recovery as to the chest, and recovery with partial anchylosis of the shoulder, without operative interference, followed, and appeared attributable chiefly to inflammatory action being subdued by repeated depletion, the use of antimonial medicines, and enforced abstinence. In two other cases, hitherto unrecorded, which occurred during the same month in the same regiment, successful terminations appeared to be attributable to similar means. In one of these the ball entered the front of the chest, between the third and fourth ribs, and passed out between the seventh and eighth ribs below; in the other, after passing through the right arm, it entered the chest at the posterior border of the axilla, and emerged near the apex of the scapula.

To remove splinters of bone, and readjust indented portions of the ribs, the finger should be introduced into the wound, and care taken that in doing so no pieces of cloth or fragments be separated and projected into the pleural sac. Notice must at the same time be taken of any bleeding vessel requiring to be secured. A pledget of lint should be laid over the wound, and a broad bandage placed round the chest, just tight enough to support the ribs, and in some degree to restrain their movements, but with an opening over each wound large enough to permit the ready access of the Surgeon to it if necessary. If the patient's comfort admits of it, he should be laid with the wound downwards, with a view to prevent accumulation of fluid in the pleura; and if there be two openings, as will be most frequently the case in rifle-ball wounds, one wound should be thus placed, and the upper one kept covered. In gun-shot wounds, closure of the parietes by adhesion is of course not to be looked for. The diet, beverages, and medicines must constantly have reference to the avoidance of inflammatory action; and should this occur, it must be combated on general principles. It is by such means we shall best assist the natural efforts towards recovery.

If the presence of a ball within the cavity be ascertained, efforts should be made for its removal. But any attempt to determine where the ball has lodged should be made very cautiously, as more harm may result from the interference than from the lodgment of the foreign body. The existence of old adhesions will modify the effects of a penetrating wound, by excluding the track of the ball from the general pleural cavity, and may influence the result of the injury, especially if there be hæmorrhage, or lodgment of foreign bodies, which may thus be brought within the sphere of removal more readily.

Wounds of the heart seldom come to the military Surgeon's notice, as they ordinarily prove fatal on the battle-field. Still it is right to mention, that examples occur in which musket-balls are lodged in the heart without immediately fatal results; and one case is recorded, where a ball was found imbedded in its substance six years after the injury was received, and death then ensued from causes unconnected with the wound.* Cicatrices have also been discovered, showing that a portion of this organ had been wounded with recovery. A private of the 2d Foot, wounded in the chest, came to England in a transport, and died sixteen days afterwards in the military hospital at Plymouth. On removing the heart, a ball was found in the pericardium. There was a transverse opening in the right ventricle, near the origin of the pulmonary artery, and the appearances led to the supposition that the ball had, previous to death, been lying in the right auricle. There was general inflammation of the heart and left side of the chest, but no signs of inflammation on the right side. A preparation of this heart is preserved.† These are only referred to as indications of what cases may occur among chest-injuries; such accidents are so rare as to lead to little practical result.

Gun-shot Wounds of the Neck.

Gun-shot wounds of this region do not appear to be so fatal as might be anticipated from the large vessels and important canals leading to the thorax and abdomen, which at first sight appear to be so exposed and unprotected. In no region are so many examples offered of large vessels meeting but escaping from balls in their passage as in this; because the cause which operates elsewhere, ready mobility among long and yielding structures, exists in a greater degree in the neck than in any other part. Where the large vessels happen to be divided, death must follow almost immediately.

Superficial wounds of the neck offer no peculiarities. The larynx and trachea being the organs most prominent, and most frequently injured, are those which chiefly attract the Surgeon's notice in warfare; but a consideration of the anatomical structure will at once show what numerous other complications, whether from direct injury or consequent inflammation, projectiles are likely to cause when driven deeply into, or perforating, this region.

A brief abstract of some wounds of the neck, which occurred during the Crimean campaign, will serve to exhibit the leading symptoms connected with them when the larynx, or larynx and œsophagus, are involved. Four cases may be found in the *Lancet* of 19th Jan. 1856, to which journal they were communicated by the late Mr. Guthrie, as "very interesting." In the surgical history of the war, it is stated, that only three wounds of the neck, other than simple flesh-wounds, occurred among the officers, from the commencement to the end of the war; of which two proved fatal, and one led to invaliding. The case of an officer of the 19th Regiment, however, fell under the care of the writer, which is not included in that number; and in this instance the neck was completely traversed, the œsophagus perforated from side to side, and the larynx injured. It is detailed among the cases by Mr. Guthrie. After the shock had subsided, the leading symptoms were aphonia, dysphagia, numbness of one arm, œdema and stiffness of the neck, distressing accumulation of mucus about the fauces, and slight pyrexia. Recovery progressed favourably, and on the twenty-second day after the injury both external wounds in the neck were healed, and the two in the œsophagus appeared to be closed also. The patient referred to still suffers from a certain amount of aphonia, but not enough to prevent him from performing his duties as a captain, though want of sufficient power of voice would probably disable him for a more extensive command. Another of these cases, in which emphysema of the neck, œdema of the glottis, great dyspnœa, and threatened suffocation gradually supervened in a superficial gun-shot wound of the neck, with fracture of the thyroid cartilage, is related by Assistant-Surgeon Cowan, 55th Regiment, who performed tracheotomy, and thereby saved the patient's life. In another, the ball passed through the thyro-hyoid membrane, fractured the thyroid cartilage, and tore the lining membrane of the glottis. Tracheotomy was performed on the day after the injury, without benefit. Liquids could not be prevented from passing into the trachea through the wound made by the projectile. The fourth case above referred to was in a private of the 97th Regiment. The ball entered at the pomum Adami, and passed out by the anterior edge of the right sterno-mastoid muscle. Loss of voice, frequent cough, bloody sputa, slight emphysema at the wound of entrance, and nausea, were the leading symptoms. When the man attempted to drink, some of the fluid escaped by the wound of exit. After five days this occurrence ceased; and after the twelfth day, air no longer passed out of the wound of entrance. Both wounds gradually healed; but aphonia—the voice being reduced to a whisper—existed when the man left the regimental hospital. A soldier of the Rifle Brigade, under the care of Deputy Inspector-General Fraser, C.B., then Surgeon of the battalion, was shot through the trachea, and respiration was for some time carried on by the wound; it, however, gradually and completely healed, and a favourable recovery ensued. Another interesting case, hitherto unrecorded, occurred in a soldier of the same battalion, at the last assault of the Redan. A rifle-ball entered this man's neck at the lower part of the left sterno-mastoid muscle, passed across under the skin, wounding the anterior surface of the trachea, severed some fibres of the right sterno-mastoid, and effected its exit. The man was wounded at the same time by two other rifle-balls, both flesh-wounds, one through the left fore-arm, the other through the upper part of the right thigh; while a shell exploding near him, caused his left eye to be penetrated with particles of stone and earth. Vision was lost; but in other respects, excepting a little lameness from the wound in the thigh, he was discharged cured, after fifty-six days' hospital treatment.

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* *Dict. des Sciences Méd.*, Paris, 1813, p. 217.

† See *Edin. Med. and Surg. Journal*, vol. xiv.,—Case of gun-shot wound of the heart, by J. Fuge, Esq.

Seven cases of gun-shot wounds of the neck returned to England from the late mutiny in India. They were all simple flesh-wounds. In one the musket-ball had not been discovered, and its position remained unknown. The man was wounded at Lucknow, and the ball entered the left side of the neck, close to the thyroid cartilage. Baron Percy reports a similar wound and case of lodgment in his *Army Surgeon's Manual;* in this instance, the ball was known to pass away by the bowels, a fortnight after the injury was received.

The liability to concussion of the cervical portion of the vertebral column, and to injury of the deep cervical and other nerves, must not be overlooked. Wounds of the neck are often accompanied by more or less loss of power in one of the upper extremities; and more extensive paralysis occasionally succeeds, although there was no primary evidence of the spine being implicated in the injury.

GUN-SHOT WOUNDS OF THE ABDOMEN.

Gun-shot wounds of the abdomen, like those of the chest, are, for the sake of convenience, divided into *non-penetrating* and *penetrating.* The *non-penetrating* may be either simple flesh-wounds, or may be accompanied with fracture of some of the pelvic bones, or with injury to some of the contained viscera. In *penetrating* wounds, the peritonæum only, or, together with it, one or more of the abdominal viscera, may be wounded; or, in comparatively rare cases, a viscus may be penetrated without the peritonæum being involved. It is in the regional cavity of the abdomen that the proportion of penetrating wounds is the greatest. The cranium, from its form, structure, and coverings, serves as a strong defence even against gun-shot; the osseous yet elastic and movable ribs, the sternum, and muscular parietes, greatly protect the contents of the cavity which they enclose; but the extensively exposed surface of the abdomen, anteriorly and laterally, has no power of resistance to offer against a projectile directly impinging it; and when this important cavity is once penetrated by these means, death is the almost inevitable result. Even the chances of a favourable termination which may exist in wounds from other causes are generally wanting; and much of their treatment, such as the use of sutures, and other means to insure the apposition of cut edges, is inapplicable, from the parts to a certain distance being almost necessarily deprived of their vitality, to injuries from gun-shot.

Non-penetrating wounds require but few remarks in this place. The fatal injuries which occasionally occur from masses of shell, or round shot, in which the liver, spleen, or other viscera, are ruptured without penetration of parietes, and where death ensues from shock, hæmorrhage, or peritonitis, have already been alluded to. If, although the viscera have been contused, the injury does not amount to being mortal, the patient should be subjected to perfect quiet, extreme abstinence, and, only when inflammation arises, to the necessary treatment for its control. If the parietes have been much contused, abscess or sloughing may be expected; and a tendency to visceral protrusion must be afterwards guarded against.

When portions of the pelvic parietes are fractured by heavy projectiles, very protracted abscesses generally arise, connected with necrosed bone; and the vital powers of the patient are greatly tried by the necessary restraint and long confinement. The great force by which these wounds must be produced, and the general contusion of the surrounding structures, cause a large proportion sooner or later to prove fatal, notwithstanding the peritoneal cavity may have escaped. Of twenty-nine such cases which came under treatment in the Crimea, sixteen died. Even apparently slight cases, as where a portion of the crest of the ilium is carried away by shell, or ball lodged in one of the pelvic bones, often prove very tedious from the long-continued exfoliations and abscesses which result.

Penetrating wounds. A penetrating wound of the abdomen, whether viscera be wounded or not, is usually attended with a great amount of 'shock.' The prognosis will be extremely unfavourable, if there is reason to fear the projectile has lodged in the cavity of the peritonæum; and in all cases the danger will be very great from inflammation of this serous investment. The liability to accumulation of blood in the cavity, from some vessel of the abdominal wall being involved in the wound, must not be forgotten.

When, in addition to the cavity being opened, viscera are penetrated, and death does not directly ensue from rupture of some of the larger arteries, the shock is not only very severe, but the collapse attending it is seldom recovered from, up to the time of the fatal termination of the case. This is sometimes the only symptom which will enable the Surgeon to diagnose that viscera are perforated. The mind remains clear; but the prostration, oppressive anxiety, and restlessness are intense; and, as peritonitis supervenes, pain, dyspnœa, diffused tenderness, irritability of the stomach, distension, and the other signs of this inflammation, are superadded. In ordinary wounds from musket-shot, scarcely any matter will escape from the opening in the parietes, the margin of which becomes quickly tumefied; but if any escape, it will probably indicate what viscus has been wounded. If the stomach has been penetrated, there will probably be vomiting of blood from the first. If the spleen or liver be wounded, death from hæmorrhage is likely to follow quickly. In some instances patients, however, recover after gun-shot wounds involving these viscera, and examples in illustration may be found in various works on military surgery. Two particularly manifest instances, where officers were shot through the liver by musket-balls, occurred lately in India; one at Lucknow, the other at the siege of Delhi: both recovered. The cases are described in the *Indian Annals of Medical Science* for January 1859. If the small intestines have been perforated, and death follows soon after from peritonitis, the bowels usually remain unmoved, so that no evidence is offered of the nature of the wound from evacuations; but in any case of penetrating wound of the abdomen, when the opportunity is offered, steps should be taken—a matter not unlikely to be omitted under the circumstances of camp-hospitals full of patients—to isolate and examine all evacuations which may follow. By attending to this direction, the writer had the satisfaction of ascertaining the passage of a ball and piece of cloth, after a wound in the loin, in a case already alluded to. If the kidneys or bladder are penetrated, the escape of urine into the abdomen is almost a certain cause of fatal result. The latter viscus may, however, be penetrated without the peritoneal cavity being opened; and, as experience proves, the wound is then by no means of a fatal character. Musket-balls sometimes lodge in the bladder. This was ascertained to have happened in a soldier of the 20th Regiment, in the Crimea; but the patient died from other injuries, so that the information could not be turned to account. Mr. Guthrie performed the usual operation of lithotomy, with success, to remove a musket-ball which had struck a soldier just above the pubes, at Waterloo, and lodged. He also records a similarly successful case in a man wounded at the battle of Chillianwallah: this ball formed the nucleus of a calculus. Baron Percy removed a ball and a portion of shirt from the bladder. In all such cases, it is probable that the bladder has been penetrated at some part uncovered by peritonæum, so that the cavity of the abdomen has not been opened; or, if otherwise, the foreign body has found its way in by ulceration, after adhesions have been established, and thus circumscribed the openings of communication. Small foreign bodies may also pass into the bladder by the ureter. A case in which the kidney was wounded came under the care of the writer, after the 8th of September 1855. The patient survived twelve days, and then died from pyæmia. He had been taken prisoner, but was found in Sebastopol, and brought to his regimental hospital on the second day after the assault. There was only one wound in the right loin, and the ball had lodged. Extensive abscesses formed among the glutæal muscles on the left side, and down the left thigh; and though free incisions were made, great constitutional irritation supervened, and he sank. The substance of the right kidney had been perforated, but the ureter had escaped. The ball had passed across the abdomen, and lodged in the left buttock. Mr. Guthrie mentions some wounds of the kidney where recovery took place; in one, seven months after the wound, after an attack of retention of urine, a piece of cloth was forced out by the urethra, which must have come down from the pelvis of the kidney. When the abdominal parietes have been opened by shell, or passage of large shot, protrusion of omentum and intestines will probably be one of the results. This does not always happen. In Dr. Macleod's *Notes*, p. 265, is detailed a remarkable case of recovery, which was witnessed by the writer, after the wall of the abdomen, including the peritonæum, had been destroyed to the extent of five inches long by three broad; and a coil of intestine laid bare without protrusion, in the right iliac region. This patient had also a fracture of the ilium, another of the great trochanter on the same side, and his right fore-arm smashed. This case was treated in the general hospital before Sebastopol, by Mr. Rooke. Sometimes a wound caused by a large projectile, which was at first not penetrating, will indirectly become so, from the severe contusion, and consequent sloughing to such an extent as to denude the viscera; and if, as is not unlikely, adhesion has taken place in the mean time between a portion of the viscera and peritoneal lining of the abdominal paries, the sloughing action may extend more deeply, and the bowel itself become opened.

Curious instances are recorded in which balls have passed directly through the abdomen without perforating any important viscus, as proved by examination after death. As an example, on the other hand, of the number of wounds which may thus be inflicted, a soldier of the 19th Regiment, on duty in the trenches before Sebastopol, who was shot through the abdomen in the act of defæcation, was found by the writer, on post-mortem examination, to have had as many as sixteen openings made in the small intestine. He survived the wound nineteen hours.

Gun-shot wounds of the colon, especially at the sigmoid flexure, appear to be less fatal, probably from structural causes as well as circumstances of position, than wounds of the small intestine. In the Museum of Fort Pitt, however, is a preparation of jejunum, exhibiting three constrictions, and supposed to have been perforated in three places, from a private of the 80th Regiment, who was shot through the abdomen at Ferozeshah, in 1845, and who died from cholera in 1851. Inspector-General Taylor, C.B., then Surgeon of the regiment, who made the examination post mortem, thus described the injured part of the intestine: "The intestines neither there nor elsewhere were morbidly adherent, but the fold of intestines immediately opposed to the cicatrix presented a line of contraction, as if a ligature had been tied round the gut. The same appearance existed in two other places." It seems more likely that the gut was contused than perforated, and that contraction gradually supervened, especially as no adhesions were found; and when wounded, the symptoms were so slight as to have led to the supposition that the ball had gone round the abdominal wall.

A gun-shot wound of the intestine, more especially the colon, may lead to fæcal fistula, and life be thus saved for a time. One such case only occurred in the Crimea, in the 19th Regiment, of which the writer was then the Surgeon; this case, which has been before casually mentioned, subsequently passed under the care of his friend Mr. Birkett, of Guy's Hospital, in which institution the patient died from the effects of albuminaria, four years after the receipt of the wound referred to. The surgical history of this case has been already published at some length in the *Lancet*;* the medical history, together with the results of the post-mortem inspection, have been detailed by Dr. Habershon, in vol. v., Ser. III., of the *Guy's Hospital Reports*. The fistula became closed at intervals, and occasionally, before other disease supervened, hopes were entertained that recovery might result. The direction and depth of the wound precluded any of the usual operations for attempting to effect a radical cure. Two cases of abnormal anus by gun-shot perforation are recorded by Dr. Williamson, among the wounded who have recently returned from India; in both instances the descending colon was the part of the bowel implicated. A similar result is recorded in a private of the 13th Regiment, wounded at Cabul in 1840.

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* For 1855, vol. i. p. 606, and vol. ii. p. 437.

Wounds of the diaphragm. Musket-balls occasionally pass through the diaphragm; and Mr. Guthrie has remarked that these wounds, in instances where the patients survive, only become closed under rare and particular circumstances. Hence the danger of portions of some of the viscera of the abdomen, as the stomach or colon, passing into the chest, and thus forming diaphragmatic herniæ; and of these, eventually, from some cause becoming strangulated. Two very interesting preparations of these accidents from gun-shot exist in the Museum at Fort Pitt. In both instances, the stomach, colon, and omentum form the hernial protrusions. In one, death occurred a year after the wound, from strangulation induced suddenly after a full meal: in the other, the soldier continued at duty twenty-two years after, and died from other causes. All the cases which occurred in the Crimea, in which openings had thus been established between the cavities of the chest and abdomen, proved fatal. A case is detailed in the *Surgical History of the War*, where the patient survived a double perforation of the diaphragm, together with a wound of the liver, six days; in another instance, where the lung, diaphragm, liver, and spleen were wounded, the soldier lived sixteen hours. The direction of the ball, hiccough, dyspnœa accompanied with spasmodic inspiration, and inflammatory signs, more particularly connected with the chest, will be the usual indications of such a wound; and in case of recovery, the risk of hernial protrusion and strangulation must be explained to the patient. Should strangulation occur, it can hardly be expected that division of the stricture could be performed, without the operation itself leading to equally certain fatal results.

Treatment. In the general treatment of penetrating wounds of the abdomen by gun-shot, the Surgeon can do little more than to soothe and relieve the patient by the administration of opiates, and to treat symptoms of inflammation when they arise on the same principles as in all other cases. The usual directions to attempt agglutination of the opposite portions of peritonæum by favourable posture cannot generally be carried out, the attempts being defeated by the restlessness of the patient. The collapse which attends such injuries may be useful in checking hæmorrhage; and the exhibition of stimulants is further contra-indicated by the risk of exciting too much reaction, should the wound not prove directly fatal. If the wound be caused by grape-shot, or a piece of shell, and intestine protrudes, it must be returned; if the intestine be wounded, sutures are inapplicable, as in an incised wound, without previously removing the contused edges. When the bladder is penetrated, care must be taken to provide for the removal of the urine, either by an elastic catheter, or, if this cannot be retained, by perineal incision. A freely communicating external wound prevents the employment of the catheter from being essential. A soldier of the 57th Regiment was wounded on the 18th June 1855 by a musket-ball which entered the left buttock, fractured the pelvis, and came out about three inches above the os pubis, and one inch to the right of the median line. The bladder was perforated; urine escaped by both openings, chiefly by the one in front. Here the catheter caused so much irritation that it was withdrawn; but the posterior wound soon ceased to discharge urine, and in eighteen days the anterior wound was free from discharge also. Seven weeks after the date of injury, symptoms resembling those of stone in the bladder came on; these were relieved on three spiculæ of bone making their escape by the urethra. About the same time the anterior wound became again open, and some pieces of bone were discharged. After ninety-seven days' treatment in the Crimea, the man was sent home; the anterior wound being still so far open that distension of the bladder, as from accumulation at night-time, led to a little oozing from it. This subsequently healed, and he was sent to duty on the 22d of November, nearly six months after the date of injury.

GUN-SHOT WOUNDS OF THE PERINÆUM AND GENITO-URINARY ORGANS.

From the position of these parts of the body, uncomplicated gun-shot wounds of them are comparatively rare. Throughout the whole of the Crimean war, the number of cases treated amounted, among the men, to 70; among the officers, only to 4. The number of deaths which resulted were 21 among the men, chiefly cases of extensive laceration involving the urinary apparatus; among the officers, none. Three men only, out of 603 who returned from the late mutiny in India to Chatham, are recorded under this class. In one, the injury was from a spent shot, which caused a bruise without laceration over the symphysis pubis, and produced persistent incontinence of urine; in each of the other two, a musket-ball wounded the left testicle, injured the urethra, and led to urinary fistula, which was, however, afterwards healed. In one, the testicle was so much injured that it was removed on the day the wound was received; in the other, it sloughed away shortly after. A corporal of the 19th Regiment, wounded in this region on the 8th September 1855, was under the care of the writer. A portion of the ascending ramus of the ischium on the right side was driven into the perinæum, the soft parts were much injured, and the right testicle was destroyed. The viscera of the pelvis escaped. He was doing well until nearly a fortnight after the injury, when nervous irritation and trismus set in, and he sank.

Perineal wounds are not unfrequently caused by shells bursting and projecting fragments upwards; but they are generally mixed with lesions of viscera of the pelvis, or fracture of its structure, or injuries about the upper parts of the thighs or buttocks. In one such case, a portion of the scrotum, the whole of one testicle, and the greater part of the other were carried away. This wound healed without fungous growth from the remaining portion of the testis. Separate wounds of the external organs of generation are usually caused by bullets. In two cases in the Crimea, a bullet entered between the glans penis and prepuce, and traversed upwards without penetrating the erectile tissue. M. Appia records a case where the ball entered the summit of the glans, traversed the whole length of the corpus cavernosum, passed under the pubic arch, and went out by the right buttock. The urethra was not opened. Double orchitis and scrotal abscesses followed; but favourable cure took place. In another case, a ball carried away the inferior part of the glans, but did not wound the urethra. A soldier of the Rifle Brigade was wounded in the Crimea by a musket-ball, which entered the right buttock and came out by the body of the penis, just below the glans, having ruptured the urethra about four inches from the meatus. The wound of the penis closed favourably. Mr. C. Hutchinson has recorded the case of a soldier of the 42d Regiment, treated at the Deal Naval Hospital, who was wounded in the upper part of the thigh by a musket-ball which lodged. Three weeks afterwards, the ball was found imbedded in the pubes, the urethra being stretched around the convex surface; and this explained the cause of a distressing distension of the penis and dribbling of urine which had existed without intermission from the time of the injury, but ceased at once on the removal of the bullet.

GUN-SHOT WOUNDS OF THE EXTREMITIES.

These injuries, always very numerous in warfare, offer many subjects of consideration for the military Surgeon. No class of wounds includes so many cases that fall under his prolonged care as this. A large proportion of wounds of the head and trunk are immediately fatal, or from the commencement contain the elements of fatal results; while wounds of the extremities, if those of the thigh be excepted, are free from this extremely serious character. The treatment to be pursued, including questions of conservation, resection, amputation, and the proper time for the adoption of these latter if determined upon, often demands the closest attention of the Surgeon. These subjects will be considered in their general bearing in other parts of this work, and only those points especially connected with the circumstances of warfare will be here referred to.

Gun-shot wounds of the extremities divide themselves into flesh-wounds and contusions, and those complicated with fracture of one or more bones. Flesh-wounds may be simple, and these offer few peculiarities, whatever their site; or they may be accompanied with lesion to nerves, or blood-vessels, or both, and these usually increase in gravity in proportion as they approach the trunk.

When complicated with fracture, the lesion is usually rendered compound by the direct contact of the projectile with the bone injured; but the fracture is sometimes simple, when caused by indirect projectiles, such as stones or splinters, or by spent balls. These injuries are liable to become further aggravated by the fracture extending into, or being complicated with, an opening of one of the joints. Joints may be contused or opened by projectiles, without apparent lesion of any portion of the bones entering into their composition; but these are exceptions to the usual order of such cases from gun-shot.

Simple flesh-wounds have already been referred to both in respect to their nature and treatment in the commencement of this essay. It is in connexion with fractures of bones and their proper treatment that the interest of Surgeons is chiefly attracted in gun-shot wounds of the extremities. From the nature of the injuries, already described, to which bones are subjected by the modern weapons of war, together with the irreparable nature of the wound in the softer structures, except after a long process of suppuration and granulation, as well as from the usual circumstances of military life, it might be anticipated that difficulty would often arise in determining which of the double set of risks and evils—those attending amputation, and those connected with attempts to preserve the limb with a profitable result—would be least likely to prove disadvantageous to the patient. Experience in such injuries has established certain rules which are now generally acted upon; some still remain *sub judice.*

Although the subject of pyæmia is considered in its general bearings elsewhere, it is right to mention here that this serious complication, as met with in gun-shot wounds, appears to be especially induced by injuries of bones, particularly those of long bones in which the medullary canal has been laid open and extensively splintered. Several circumstances probably conduce to this result: the prolonged suppurative action during the removal of sequestra, the irritation caused by sharp points and edges, sometimes increased by transport from primary to secondary hospitals, the patulous condition of veins in bones leading to thrombosis, being its chief local sources; while depressed vital power from any cause, and continued exposure to an impure atmosphere from the congregation of numerous patients with suppurating wounds, are the principal agents in producing the state of constitution favourable to its development and progress. Unless the hospital miasmata engendered in this way are constantly removed as they arise, or very greatly diluted by proper ventilation, it is almost impossible that patients labouring under severe wounds of the extremities with comminuted bony fractures can be long saved from septicæmia and pyæmia; and these, when they supervene, rarely lead to any but a fatal termination. The different conditions of hospital air, which in one set of cases lead to the appearance of hospital gangrene, in another set of pyæmia, are not properly understood; but from the frequency with which the latter complication follows wounds of bones, it would seem that an especial influence is exerted by the local peculiarities of these injuries already mentioned. However, observation would also lead to the belief that certain individuals are much more predisposed to pyæmic action than others placed under similar circumstances. Occasionally, in gun-shot injuries of bones, where no splintering has occurred, but only a small portion of the periosteum has been torn off and the shaft contused by the stroke of a bullet, severe inflammation will follow, the medullary canal become filled with pus, and death ensue from pyæmia. The attention of Surgeons has been particularly called to the various circumstances producing inflammation and suppuration of the medullary tissues—osteo-myelitis—in long bones after gun-shot injuries by M. Jules Roux of Toulon.*

Upper extremity. Fractures of the bones of the arm are well known to be very much less dangerous than like injuries in the corresponding bones of the lower extremity. Unless extremely injured by a massive projectile, or longitudinal comminution exist to a great extent, especially if also involving a joint, or the state of the patient's health be very unfavourable, attempts should always be made to preserve the upper extremity after a gun-shot wound. In the Director-General's *History of the Crimean Campaign*, the recoveries without amputation are shown to be in the humerus 26·6; radius and ulna, 35·0; radius only, 70·0; ulna only, 70·0, per cent of cases treated. The proportion of deaths in these cases was only 2·3 per cent. Although not the result of gun-shot, a remarkable case, published by Staff-Surgeon Dr. Williamson, by whom the operation was performed, serves to illustrate how extensively bone may be removed from the upper arm, and a useful member be still retained. The details will be found in his *Notes on the Wounded from the Mutiny in India.* The whole of the ulna (not merely sequestra, but also the new bone which had formed around them, the object of which proceeding is not stated), two inches of the humerus, and the head and neck of the radius, were removed, and four months after the operation the man could "bend his fore-arm, raise his hand behind his head, lift a 28 lb. weight from the ground, pronate and supinate the hand, and use his fingers well." Of 194 wounds and injuries of the upper extremity among men returned from the late mutiny in India, 100 are recorded by Dr. Williamson to have been sent to duty regular or modified, 67 invalided from the service, 1 died, and 26 were still under treatment.

In the latter part of the Crimean campaign, when the health of the troops and means of treatment were favourable, it was often remarkable what extensive injuries of the upper extremity, even where the joints were involved, were repaired without amputation. The following cases are examples: Sergeant Bacon,

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* *Bulletin de l'Académie Impériale de Médecine*, 24th April 1860. See also *Des Amputations consécutives a l'Ostéomyélite dans les Fractures des Membres par armes a feu*, par M. H. Baron Larrey, Paris, 1860.

7th Fusileers, ætat. thirty-six, at the attack on the Redan on 8th of September 1855, was wounded by a rifle-ball, which entered the head of the left humerus, shattered the bone very much, and was extracted from below the left scapula. Dr. Moorhead determined to try to preserve the limb. The head of the humerus required to be removed in small broken fragments, and the shaft, being found to be split down between three and four inches, was to that distance removed by the saw. The case progressed favourably, and in 1857 this man was in London with a most useful arm. A young soldier of the 23d Regiment was wounded on the 15th August 1855 by a large grape-shot, which passed through the right arm near the shoulder, comminuting the bone for three inches, and extensively destroying the soft parts. Staff-Surgeon Williams, in medical charge, despairing of saving the limb, proposed to amputate; but at the suggestion of the late Director-General Alexander, then principal medical officer of the Light Division, arranged to allow some days to elapse to watch symptoms. The case progressed so well that the idea of amputation was abandoned, and the man recovered with a very serviceable arm. In another regiment of the Light Division, the 77th, a healthy young soldier, under the care of Surgeon Franklin, was wounded at the last assault of the Redan, and sustained a comminuted fracture of the humerus, had the elbow-joint opened, both bones of the fore-arm broken about two inches below the joint, and the soft parts widely opened, by a piece of shell. Here no excision was practised, but fragments removed as they became loose; the arm, with its dressings, was supported on a zinc-wire cradle, hollowed out and bent at the elbow to the desired angle; and nourishment, with malt liquor, were freely given from the first day. Anchylosis was established, and he left for England with a useful limb. The fractures above and below the joint prevented the application of passive motion.

In these injuries, where the bone is much splintered, the detached portions, and any fragments which are only retained by very partial periosteal connexions, should be removed; projecting spiculæ sawn or cut off;[*] the wound being extended at the most dependent opening where two exist, or fresh incisions being made for this purpose, if necessary; light water-dressing applied; the limb properly supported, and the case proceeded with as in cases of compound fracture from other causes (see FRACTURE). The same general rules also apply in preserving as much of the hand as possible, in gun-shot injuries. If the shoulder or elbow joint be much injured, but the principal vessels have escaped, the articulating surfaces and broken portions should be excised. Care should be taken to see that the projectile has wholly passed out, or been removed. In a case of comminuted fracture of the humerus, in the 88th Regiment, no union having taken place a month after the injury, and some dead bone requiring removal, an incision was made for this purpose, when half the bullet was found between the fractured ends. Good union, with free motion of the arm, resulted, after this foreign body and the necrosed bone were taken away. The results of excision practised in the shoulder and elbow joints, especially the former, after gun-shot wounds, have been exceedingly satisfactory. Especial attention was directed to the practice of resections of joints, after gun-shot injuries in the Schleswig-Holstein campaigns, between 1848 and 1851; and Dr. Friedrich Esmarch has published the results in a valuable essay on the subject. Of nineteen patients in whom the shoulder-joint was resected, in twelve a more or less useful arm was preserved; and seven died. Complete anchylosis did not occur in any one instance; and in several the power of motion became so great as to enable the men to perform heavy work. Of forty patients for whom resection of the elbow-joint was performed, six died, thirty-two recovered with a

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[*] Dupuytren made a division of the splinters of bones broken by gunshot into three classes: viz. primary sequestra, those directly and completely separated by the force of the projectile; secondary sequestra. those retaining partial connexions by periosteal, muscular, or other attachments, but afterwards thrown off during the suppurative process; and tertiary sequestra, or necrosed portions. produced by the effects of the contusion and prolonged inflammatory action in parts adjoining the seat of

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fracture. In accordance with this arrangement, the removal by the Surgeon of the primary and secondary splinters has been regarded as simply anticipating nature in her work; but Dr. Esmarch states, as one result of the experience of the Surgeons of the Schleswig-Holstein army, that in the majority of comminuted fractures, the removal of splinters retaining any connexion with periosteum is unnecessary, and often injurious; as is also the practice of sawing off the broken ends of the bone projecting from the comminuted part. By proper treatment and under favourable circumstances, he asserts, such splinters become impacted in callus, and in time unite with the other fragments of the bone, and in this manner a cure is completed without operative interference. It is a matter, however, of frequent observation, that splinters which have thus become impacted in callus lead to mischief in various ways, or are subsequently discharged as if they were so many foreign bodies, while the removal of the jagged ends of the broken bone seems to be a valuable means of preventing irritation, and thus of favouring union between them; and English Surgeons, therefore, generally pursue the practice above recommended.

more or less useful arm, one remained unhealed at the time Dr. Esmarch wrote (1851), and in one mortification ensued and amputation was performed. These operations present no peculiarities in the mode of performance or their after treatment, as compared with similar resections in civil practice.

Lower extremity. Gun-shot wounds of the lower extremity vary much more greatly in the gravity of their results, as well as in the treatment to be adopted, according to the part of the limb injured, than happens in those of the upper extremity. As a general rule, ordinary fractures below the knee, from rifle-balls, should never cause primary amputation; while, excepting in certain special cases, in fractures above the knee, from rifle-balls, amputation is held by most military Surgeons to be a necessary measure. The special cases are, gun-shot fractures of the upper third of the femur, especially where the hip-joint is implicated; for in these the danger attending amputation itself is so great, that the question is still open, whether the safety of the patient is best consulted by excision of the injured portion of the femur, by simple removal of detached fragments and trusting to natural efforts for union, or by resorting to amputation. The decision of the Surgeon must generally rest upon the extent of injury to the surrounding structures, the condition of the patient, and other circumstances of each particular case. If the femoral artery and vein have been lacerated, any attempt to preserve the limb will certainly prove fatal.

The femur—the earliest formed, the longest, most powerful, and most compact in structure of all the long bones of the body—can only be shattered by a ball striking it with immense force. Attention was specially directed in the late Crimean campaign to the question of the proper treatment of these injuries, and expectations were generally held that the advanced experience in conservative surgery would lead to many such cases terminating favourably with preservation of the limb, which previously would have been subjected to amputation. Towards the latter part of the war, all the circumstances of the patients were as favourable for testing this practice as they have been in the various *émeutes* in Paris, with the advantages of immediate attention and all the appliances of the best hospitals close at hand. Yet, in the *Surgical History of the Campaign*, it is stated that only fourteen out of 174 cases of compound fracture of the femur among the men, and five out of twenty among the officers, recovered without amputation being performed; that those selected for the experiment of preserving the limb were patients where the amount of injury done to the bone and soft parts was comparatively small; that where recovery ensued, it always proved tedious, and the risks during a long course of treatment numerous and grave; and that the proportion of recoveries would not appear even so large as the above, if the deaths of those who after long treatment were subjected to amputation as a last resource were included. Amputations of the thigh, however, were very fatal in their results also, the recoveries being stated to be, among the men, in the upper third $12\frac{9}{10}$, in the middle third 40, in the lower third $43\frac{3}{10}$, per cent of cases treated. Among the officers the proportion was rather more favourable. But this percentage includes those cases in which attempts had been made to preserve the limb, and failure resulting, amputation was resorted to as a last chance of saving the patient; so that they ought to have been excluded from the lists of amputations, both primary and secondary, as commonly interpreted. On account of this comparatively indifferent success of amputation, resection of portions of the shaft of the femur was sometimes practised; but the records state that no success attended the experiment, every case, without exception, having proved fatal.

In considering the results of gun-shot fractures of the femur, the situation of the injury is a matter of great importance, whether as regards chances of recovery without or with amputation. In the *Surgical History of the Crimean Campaign* this fact is shown in the results of amputation; but the distinction is not made in regard to the recoveries without amputation. Dr. Macleod, in his *Notes*, remarks that he has only been able to discover three cases in which recovery followed a compound fracture in the upper third of the femur without amputation; one, that of an officer of the 17th Regiment; the second, of a soldier of the 62d; and a third, whose regiment is not named. A case, however, was under the care of the writer, not included in the above, nor appearing in the official history of the war; and one, judging from the results described in Dr. Macleod's *Notes*, more fortunate in its issue than at least two of the number he mentions. With regard to the first patient, Dr. Macleod states he has been informed "that although his limb was in a very good condition when he left for England, the trouble it has since given him, and the deformed condition in which it remains, makes it by no means an agreeable appendage;"* in the second, the fracture was in the lower part of the upper third, and the injury was comparatively slight; in the third, a mass of callus was thrown out which connected the bone, but he died of purulent poisoning, and never left the Crimea. In the case which was under the writer, the fracture was within the upper third; there is no distortion, and shortening only of 1½ inches: the officer is able to walk or ride without any inconvenience, and competent for all duty. All the circumstances were most favourable for recovery in this instance; and a consideration of these on the one hand, and the experience of the unfavourable results of amputation in this region on the other, led to the effort to save the limb. A short history of this case will be useful. Lieutenant D. M., 19th Regiment, æt. 17, of sanguine temperament, healthy frame, was brought up to camp about 4 a.m. Sept. 9th, 1855. He had been wounded in the assault upon the Redan in the upper part of the left thigh, and had been lying by the side of the ditch where he fell thirteen hours. When discovered, he was carried carefully in a soldier's greatcoat as far as the opening of the trenches, and thence on a stretcher to camp. He was very cold and prostrate on his arrival. The wound in his left thigh had been caused by a ball which had passed out. It entered posteriorly at the fold between the left nates and thigh, three inches from the tuberosity of the ischium; passed forwards, downwards, and outwards, and made its exit seven inches below the trochanter major. The femur was broken in the line of passage of the ball, which, from entrance to exit, appeared to be about six inches. From the trochanter major to the seat of fracture was four inches; to the external condyle on the same side was 15½ inches. The amount of comminution appeared slight, but, from its vicinity to the joint, the great swelling about the limb, and desire to avoid aggravating pain, the precise condition of fracture was not further ascertained. The upper fragment projected forwards, but any attempts at reduction caused great suffering; and some restoratives being given, wet compresses applied to the thigh, and the limb secured against additional movement, the patient was left to rest. At a consultation the following morning, from the patient's age, so favourable for reparative action, very healthy constitution, and the fact that, the siege being over, full attention could be paid to the case, conservation of the limb was settled to be attempted, and the patient was therefore treated with this view. In addition to the wound just named, he had received an extensive contusion of the right thigh by the fall of some heavy substance from the explosion which occurred at one A. M., after the Russians left the Redan.

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* The officer referred to must have greatly improved in condition since Dr. Macleod wrote, as he has been of late on active service in India.

There is not space to follow the details of the treatment of this case. The cure was protracted by large and troublesome bed-sores; and attention to these, to the discharges from the wound, and preserving favourable position, occupied much time and care daily, and caused many changes in the appliances for these objects to be from time to time necessary. On November the 4th, union had so far taken place that he was able to raise his body from the knee upwards while in bed, without apparent motion at the seat of fracture. On November 15th, in consequence of the great explosion at the right siege-train, he had to be carried to another division of the camp; this was effected without harm. In the middle of January he was able to sit in a chair without inconvenience; and on February 22d he left the Crimea for England, being able to walk with the assistance of crutches. Union was then firm; but a slight serous oozing continued from the wound of exit, and there was much stiffness of the ankle and knee joints from the long-continued constrained position to which he had been subjected. In July 1856, after his arrival in Ireland, indications of pus collecting manifested themselves at the wound of exit; and Professor Tufnell, on passing a bougie about seven inches in the course of the wound, evacuated a small abscess, and felt a piece of bone trying to make its way to the surface. This was subsequently removed, and, under Mr. Tufnell's able care, the stiffness of the joints gradually disappeared, and he was enabled to return to duty.

Dr. Macleod says that, after many inquiries respecting cases of this nature in the hospitals of the other armies engaged in the war, excepting one presented by Baron Larrey to the Société de Chirurgie in 1857, he never could hear of any other but that of a Russian whose greatly shattered and deformed limb he often examined.* It had united almost without treatment. Two cases of united fractures of the femur in the upper third have arrived from the late mutiny in India, and in both, Dr. Williamson records, a good and useful limb had resulted, one with shortening of 1$\frac{1}{2}$, the other 3$\frac{1}{2}$, inches. Still more recently, M. Jules Roux, of the St. Maudrier Hospital, at Toulon, has given a list of no less than twenty-one cases of gun-shot injuries of the upper third of the femur, which he had examined on their return from the Italian war of 1859, in all of which consolidation of the fracture had taken place. We have no data by which we can estimate the proportion of these cases of union to those in which other results ensued.

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* *Notes on the Surgery of the Crimean War*, p. 295.

The proportion of recoveries in amputations in the upper third of the femur in the Crimean war was under 13 per cent. Amputation at the hip-joint, both in the French and English armies, in all instances proved fatal. The two patients who survived the longest were operated on by the late Director-General after the battle of the Alma: one, a soldier of the 33d Regiment, died at Scutari three weeks after the operation; the second, a Russian, died on the thirtieth day after, from "extensive sloughing and great debility."* One case of excision of the head, neck, and trochanter of the femur in the Crimea recovered, operated upon by Dr. O'Leary; the only known successful case of excision of the hip-joint after a gun-shot wound. The operation was performed on the same day that the wound was received. In the Schleswig-Holstein campaigns, amputation at the hip-joint was performed seven times; one patient only survived, a young man, æt. 17 years, operated upon by Dr. Langenbeck. Resection of the upper part of the femur, including the head and two inches below the small trochanter, was performed once, but the patient died from pyæmia. At the post-mortem examination, the right shoulder and ankle joints were found to be filled with pus. The operation in this instance was performed three weeks after the injury. No case of amputation, nor of resection, at the hip-joint has returned from the Indian mutiny. M. Legouest, in a recent essay in the *Memoirs of the Society of Surgery*, at Paris, maintains that amputation at the hip-joint should be reserved for cases of fracture with injury to the great vessels, and that where the vessels have escaped, resection should invariably be performed. He also inculcates, as a general principle, not to perform immediate *primary* amputation at the hip-joint in any case; but, even in the severest forms of injury, to postpone the operation as long as possible.† For the *consecutive* results of gun-shot wounds, the operation presents a less unfavourable aspect than for immediate injuries. M. Jules Roux has recently, at Toulon, performed amputation at the hip-joint six times for the consequences of wounds received during the war in Italy, and of these, four have been successful.

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* In the surgical history of this war, this statement, which was quoted by the late Mr. Guthrie, in the Addenda to his *Commentaries*, is said to be a mistake, on account of the absence (not to be wondered at, amid the confusion of that period) of official records on the subject. Special reports on these cases were obtained at the time from Scutari, and were shown to the writer by the late Director-General shortly before his decease.

† A committee was appointed by the Surgical Society of Paris to examine and report upon this essay of Dr. Legouest on Coxo-femoral Disarticulation for Gun-shot Wounds. Baron Larrey drew up the report, which will be found in the 5th vol. of the *Mémoires de la Societé de Chirurgie*, 1860. It confirms the principle laid down by Dr. Legouest, excepting only those

With regard to gun-shot fractures in the middle and lower third of the femur, the experience of the French and English armies in the Crimea has tended to confirm the doctrine of the older military Surgeons, that many lives are lost which might be otherwise preserved, by trying to save limbs; and that, of the limbs preserved, many are little better than incumbrances to their possessors. In the late Italian battles, the practice of trying to save lower extremities after comminuted fractures in these situations of the thigh appears to have been abandoned. Eight cases of union after compound gun-shot fractures of the femur in these situations have, however, returned from the late mutiny in India, and this is a much larger proportion than was that of the recoveries from the Crimea. Dr. Williamson, who records these cases, is inclined to attribute this success in a great measure to the use of dooleys for the conveyance of wounded, and argues that it would be advantageous to introduce them into European warfare. But wounds generally, where proper care is taken, heal more favourably in southern latitudes, east or west, probably owing to the climate admitting of so much more free an access of fresh air by day and night to the patient than can be afforded, without inconvenience, in colder or more variable climates. The dooley is most advantageous and comfortable as used in the East, where it is an ordinary mode of conveyance among all classes, and the bearers—a special race in each Presidency—are trained from childhood to the occupation; but, from experience of the peculiar habits and tenets of these men, both Madrassees and those of Bengal, it seems scarcely probable that they would prove efficient, even if they could exist, or that their wants could be provided for in the numbers necessary to be serviceable, with armies in northern latitudes. French Surgeons have remarked how much more favourably, *cæteris paribus*, wounds heal in Algeria, where they have only the same kinds of conveyance for wounded as in Europe; and the difference is accounted for by the favourable influence in this respect of a warmer climate.

In fractures of the leg, where neither the knee nor ankle joints

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cases of fracture where the mutilation of the limb from a heavy projectile has been so great as to partly separate it from the pelvis, and those in which there has been simultaneous lesion of the crural vessels and femur near the pelvis, with extensive laceration of the surrounding tissues.

are implicated, the results of conservative attempts have been more favourable. In the Crimea, the recoveries without amputation being resorted to were, in fractures of both bones, nearly 19; tibia only, 36·3; fibula only, 40·9 per cent. When the fracture is comminuted, and implicates the knee or ankle joint, opening the capsule, amputation is necessary. The knee-joint was once excised in the Crimea, but the patient died; as was the case in the only other instance where this operation is known to have been performed for gun-shot injury in the Schleswig-Holstein campaign. In the treatment of fractures of the leg where it has been determined to seek union, the same remarks apply as those made above in respect to fractures in the upper extremity. In wounds of the foot it is especially necessary to remove as early as possible all the comminuted fragments of the bones injured, or tedious abscesses, and much pain and constitutional irritation, are likely to ensue.

AMPUTATION.

It is not necessary to refer at much length to the question which was formerly disputed upon, the advantages of *primary* as compared with *secondary* amputation in gun-shot wounds; for military Surgeons, whether acting at sea or on land, have practically determined the subject. For a long time the directions of John Hunter, that amputation should not be performed until the first inflammation was over, based on the argument that the "amputation is a violence superadded to the injury, and therefore heightens the danger," and that this danger is aggravated in the instance of a man labouring under mental agitation, as on the field of battle, had great weight among English Surgeons; but experience has led to a different practice. The greater success of primary amputation appears to be attributable to the facts, that a contused and mangled limb is a constant source of accumulating irritation; that the exciting circumstances connected with battle lead a man to bear with courage at an early stage what subsequent suffering and anxiety may render him less willing to submit to; that a soldier, when first wounded, is most probably in stronger health than he will be after hospital restraint and confinement; that though the amputation is a violence, it is one the patient is likely to submit to with resignation, knowing that it is performed to remove parts which, if unremoved, will destroy life; and lastly, because the operation takes away a source of dread which must weigh down the sufferer so long as it is impending. The present practice has resulted from testing both modes of amputation. Mr. Guthrie showed, from the experience of the Peninsular War, that the loss in secondary amputations had constantly exceeded that from primary amputations in both the upper and lower extremities. More recent observations in both English and French campaigns have confirmed this result. Dr. Scrive records that the experience of the French army in the Crimea showed the success of primary amputation sometimes exceeded by two-thirds that of secondary amputation. He excepts amputations at the hip-joint, and cites, as his reason for this exception, that in nine cases where the hip-joint amputation was performed primarily, death followed the operation a few instants or a few hours afterwards; while in three cases which he witnessed, where the amputation was consecutive, one lived five, another twelve, and the third twenty, days. In respect to the particular time at which primary amputation is to be performed, the general practice of the present day is, when the operation is inevitable, to perform it as soon as it can be done; provided the more intense effects of 'shock,' where it has supervened on the injury, have passed off; and this practice generally accords with the feelings of soldiers, who not unfrequently press the Surgeon for an early turn in being relieved from the suffering resulting from a shattered limb. In the cases where primary amputation is to be performed, a further reason given by Dr. Scrive for the operation being done on the same day that the wound is received is, that chloroform acts then so much more benignantly and readily; while, on the following day, or day after, traumatic excitement becomes very energetic, and considerable resistance is offered to its influence by wounded men, and longer time and a much larger dose of the chloroform are required to produce the state of anæsthesia. If only a moderate amount of 'shock' exist, this does not appear to be a sufficient reason for delaying amputation; for a moderate exhibition of stimulus and a few consolatory words will often remove this, and even though some faintness, pallor, and depression remain, no ill consequences ensue. The late Director-General, in a letter to the late Mr. Guthrie, written in 1855, mentioned the case of a soldier of the 90th Regiment, whose right arm he removed at the shoulder-joint on the 10th of July, for great destruction of soft parts and extensive injury to the bone. "The patient was so low when placed on the table that brandy-and-water were given to him, and he was then immediately afterwards placed under chloroform. When I had finished, it was observed that his pulse was stronger than before the operation." This man recovered without a bad symptom, and is now one of the Commissionaires in London. Indeed, in the Crimea, primary amputations were repeatedly performed where shock had not wholly disappeared, and no harm resulted from the practice. The introduction of chloroform, by its negative operation of preventing pain or alarm, and by its positive action as a stimulus, has done much to remove many of the objections which were urged by John Hunter against early amputations after gun-shot wounds. If collapse be intense, more than is accounted for by the wound to the extremity, suspicion will be excited that some internal injury has been also inflicted, and delay will be necessary for further observation of the patient. When active operations are proceeding, and it is necessary to carry the wounded to any distance, the advantages of early removal of shattered limbs are obvious.

SECONDARY HÆMORRHAGE.

Army Surgeons meet in practice with secondary more frequently than primary hæmorrhage in gun-shot wounds. It may arise in several ways. Sometimes it results from the coagulum being forced out of an artery in which hæmorrhage had previously been spontaneously averted by the ordinary natural process, this accident being consequent upon muscular exertion or increased impulse of the circulating system from any cause. This occurrence in the bottom of a deep wound will be often found to be a very troublesome complication. Sometimes an artery, which did not appear to be injured in the first instance, ulcerates or sloughs; or, without direct injury, a vessel may become involved in unhealthy deterioration of the wound, and give way; or in a granulating wound general capillary hæmorrhage may be excited by stimulus of any kind, such as venereal excitement or excess in drinking; or the coats of the vessel may ulcerate under pressure from a detached fragment of bone or from some foreign body; or the artery may be accidentally penetrated by the end of a sharp spiculum. Secondary hæmorrhage has been said to arise from increased arterial action, from the first to the fifth day; from sloughing, the effects of contusion, from the fifth to the tenth; from ulceration, to any more distant date. M. Baudens has remarked that he has observed secondary hæmorrhage to be most frequent about the sixth day after the wound; the traumatic fever having then reached its highest point of intensity, and the sharp hurried contractions of the heart having most power in forcing out the coagula. If we could compare all the cases of hæmorrhage which occur, secondary would, perhaps, statistically appear less dangerous than primary hæmorrhage; for the latter, when happening from large vessels, must be very generally fatal, while, when hæmorrhage occurs in them secondarily, the collateral branches have become partially adapted to the interruption of the flow of blood through the regular channel. Moreover, the larger arteries, when once filled with coagula and well contracted, fortunately do not frequently yield to the impulse which serves to produce secondary hæmorrhage in vessels of smaller calibre.

Secondary hæmorrhage is not uncommon after deeply penetrating gun-shot wounds of the face, and sometimes it is difficult to determine the site of the bleeding vessel. It may be so situated that the rule of tying both ends of the bleeding artery in the wound cannot be carried out, and where, if the ordinary styptics fail, resort must be had to the ligature of the common trunk from which the bleeding vessel branches. In the Museum at Fort Pitt is a cranium showing the passage of a musket-ball from the inner side of the right orbit to the entrance of the carotid canal in the petrous portion of the temporal bone, where the ball had lodged. Death ensued, ten days after the wound, by hæmorrhage from the internal carotid. In another case, a branch of the external carotid artery was wounded by a ball which penetrated at the zygomatic fossa. Secondary hæmorrhage ensued, and the usual means failed to arrest it. The external carotid was tied; but blood continued to flow, though less abundantly than before. Compression in the wound, which failed previously, now served to arrest the hæmorrhage, and cure followed. Care must be taken, before tying the trunk, that pressure upon it exerts control over the hæmorrhage from the wound; for the irregular course of projectiles is not unlikely to lead to mistakes, such as tying the common carotid, which is stated to have been done when the hæmorrhage has been from the vertebral artery.

The rule of treatment, however, holds good in secondary as in primary hæmorrhage,—the bleeding vessel must be secured at the wounded part whenever practicable, and it must be tied both above and below the line of division, taking care to ascertain that the spot where each ligature is applied is sound. Hæmorrhage from general oozing, from sloughing, and other causes, must be treated on the general principles applicable in all such cases. (HÆMORRHAGE, Vol. I.)

WOUNDS OF NERVES.

Temporary paralysis from contusion of a nerve in the passage of a projectile is not unfrequent. Complete loss of power of motion and sensibility in a limb occasionally follows gun-shot injuries, and generally indicates complete division of the nerve. Instead of complete paralysis, there may remain only modified deprivation of sensibility, partial loss of muscular force, and diminished power of resisting cold, with or without pain; and these symptoms may either be the result of contusion, with the effects, perhaps, of inflammatory action, or of partial division. When a foreign body is lodged in or among nerves, it may induce tetanic symptoms of a fatal character, or great irritation and intense pain may result; and unless the source of these latter symptoms can be found and removed, if in a large nervous trunk of one of the extremities, they will sometimes lead to the necessity of amputation. The gun-shot injuries which cause division of large nerves, however, are usually attended with so much destruction of other parts, that the question of amputation has scarcely ever to be considered in reference to lesions of nerves alone. Atrophy of tissues and contractions of muscles are common results of injuries to nerves from gun-shot, and often lead to soldiers being disabled for further service. Occasionally, after severe injuries, the functions of sensation and power of motion gradually return, in some instances with perfect cure, but mostly with impaired power of resisting rapid alternations of temperature, especially cold. A case is mentioned in the *Surgical History of the Crimean War*, where a soldier had the right sciatic nerve severely injured by the passage of a musket-ball. Total loss of sensation in the right foot followed. The wound was healed a month after it was received, and sensation slowly returned in the foot; but the restoration was attended with intensely burning pain, unrelieved by any applications. Gradual recovery took place. Dr. Williamson's returns show eight cases of gun-shot wounds with direct injury to nerves among the men invalided from India, after the late mutiny; all were wounds involving the brachial plexus, and in all there was paralysis, partial or complete, of the upper extremity on the injured side. In one case, the loss of function appears to have been almost confined to the hand; all the fingers were fixed in a straight position, and numb, and any attempt at bending them occasioned intense pain in the course of the median nerve. The hand was cold, and affected with nervous tremor, but the motor power and sensibility of the thumb were preserved. The following hitherto unrecorded case illustrates several points. A soldier of the 37th Regiment was wounded at Azimghur, on the 27th of March 1858, by a musket-ball, through the right side of the neck. It entered just below the horizontal ramus of the jaw, and made its exit behind, over the scapula. About three pints of blood escaped, supposed to be from the external jugular vein. The wound healed favourably, but he lost the use of his right arm, at first completely, and afterwards partially, for three months. At the expiration of that period the power of the arm was restored, but he was invalided home on account of severe pain in the back of the neck, "resembling toothache," which all treatment failed to relieve. This pain spontaneously and gradually ceased; there is still some loss of substance of the trapezius muscles of the right side of the neck, and of the right as compared with the other arm, with occasional numbness when the man is in heavy marching order; but in all other respects he is well, and is at his regular duty.

TETANUS.

One cause of fatal termination in gun-shot wounds is tetanus. It is generally believed that the proportion of deaths from this source is greater after actions in tropical climates, and that exposure to the night-air in such regions has some especial effect in producing them. The most common cause appears to be, however, the local injury to nerves, already mentioned, producing irritation along their course, and so leading to some morbid condition of the ganglionic portions of the motor tracts of the spinal cord. In the Crimean campaign, the proportion of tetanus was remarkably small as compared with former wars, being, according to the returns, only 0·2 per cent of the number wounded. Dr. Scrive records, that not more than thirty cases of tetanus occurred among the French wounded during the whole Crimean war, and this would show a somewhat less ratio even than in the British army. Dr. Stromeyer records only six cases of tetanus among 2000 wounded in the campaign of 1849 against the Danes. Three of these, in which the disease assumed a chronic form, recovered. There was only in one case injury of bone. Warm baths and opium were the remedies in the successful cases.

Sir G. Ballingall made the calculation that one in seventy-nine is the average number of tetanic cases amongst wounded, and states that the proportion of recoveries is so small as scarcely to be taken into account. Three cases occurred to the writer, in the Crimea, after gun-shot wounds: all proved fatal. In one there was a severe fracture of the ischium and injury of testicle by grape-shot. In a second, a rifle-ball entered just above the left knee, and lodged. Eight days after the injury, an abscess was opened near the tuberosity of the ischium, and the ball was removed from that spot. The same day, tetanus set in, and he died three days afterwards. The ball had injured the sciatic nerve, which was found to be reddened superficially, while the neurilema also, under an ordinary magnifying-glass, showed indications of inflammation. A piece of cloth was found lying midway in the long sinus-like wound made by the ball. In a third, the bullet passed through the axillary region. The patient progressed favourably for some days, when tetanic symptoms appeared, and under these he sank. At the post-mortem examination, some detached pieces of woollen cloth were found lying entangled among the axillary plexus of nerves. Twenty-one cases altogether supervening on gun-shot injuries are shown in a table in the Crimean records. Of these, ascertained injuries to nerves by projectiles, or division of nerves by amputation, occurred in eleven cases; three followed compound fractures, and seven flesh-wounds. The average period at which the tetanic symptoms appeared was eight days and a half after the receipt of the injury; their duration prior to death, three days and a half. One case only recovered; a soldier of the 93d Regiment, wounded in the right buttock by a shell-explosion. A fragment nearly a pound in weight was removed soon after the injury. Seventeen days after, trismus set in, when a further examination of the wound led to the discovery of an angular fragment of shell which had been previously overlooked. It was deeply lodged, and resting on the sciatic nerve. On removing this, which weighed eighteen ounces, the sheath of the nerve was seen to be lacerated to nearly one inch in extent. Calomel and opium were now given, salivation appeared three days afterwards, the trismus subsided, and the man gradually convalesced.

Beyond the extraction of any foreign bodies which may have lodged, as in this last case, it is not known that there are any indications for special treatment of tetanus as occurring after gun-shot injuries. The employment of woorali has again been brought into notice by its successful administration by M. Vella, of Turin, in the case of a French sergeant wounded in the metatarsus of the right foot, on the 4th of June 1859, at the battle of Magenta, by a musket-ball which lodged. The projectile was extracted three days after his admission into hospital at Turin, on the 10th of June, and tetanus set in three days afterwards. But the woorali failed in two other cases; and it has yet to be determined, should it be found to possess any peculiar power over tetanic spasm, to what class of cases its properties are applicable. (See TETANUS.)

HOSPITAL GANGRENE, a common disease of wounded soldiers, when circumstances of war lead to over-crowding in ill-ventilated buildings, and to deficiency in the proper number of attendants for securing personal cleanliness and purity of atmosphere, with inferior diet; and PYÆMIA, a frequent cause of fatal termination after gun-shot fractures, injuries of joints, and other suppurating wounds, especially under the influence of circumstances like those above named, are treated separately under their respective heads.

ANÆSTHESIA IN GUN-SHOT WOUNDS.

The complete applicability of chloroform on the field to injuries caused by gun-shot, as to all others in civil practice, is established among Continental Surgeons, and among a majority of British army Surgeons. The first opportunity of testing chloroform largely as an anæsthetic agent in British military surgery occurred in the Crimean war, and a long report on the subject will be found in the published *Surgical History of the Campaign.* The general tenor of this report is to limit considerably the use of chloroform,—in minor operations on the ground of occasional bad results, even when the drug is of good quality and properly administered; or, in cases where the shock is very severe, on the ground that such do not rally, owing to the depressing effect of the drug, after the anæsthesia has gone off; or in secondary operations, from the systems of the patients having been much reduced by purulent discharges. But from the report it appears that only one patient died from the effects of chloroform, and in this instance Professor Maclagan, of Edinburgh, to whom a portion was forwarded for examination, reported the drug to be "acrid and nauseous when inhaled," and "totally unfit for use." On the other hand, Dr. Scrive, chief of the French Medical Department in the East, has written in his *Relation Médico-chirurgicale de la Campagne d'Orient*, p. 465: "De tous les moyens thérapeutiques employés par l'art chirurgicale, aucun n'a été aussi efficace et n'a réussi avec un succès aussi complet que le chloroforme; jamais, dans aucune circonstance, son maniement sur des milliers de blessés n'a causé le moindre accident sérieux;" and more recently, Surgeon-Major M. Armand has written: "During the Italian war, chloroform was as extensively used and was as harmless as in the Crimea. I never heard of an accident from its use."

At the commencement of the Crimean war, the Inspector-General at the head of the British Medical Department circulated a memorandum "cautioning medical officers against the use of chloroform in the severe shock of serious gun-shot wounds, as he thinks few will survive where it is used;" but, as far as chloroform was available, it was used by many medical officers from the commencement of the campaign, and its employment became more general as the campaign advanced. It was constantly used in the Division to which the writer belonged throughout the war, and no harm was ever met with from its use, while certain advantages appeared especially to fit it for military surgical practice. So far from adding to the shock of such cases as an army Surgeon would select for operation, the use of chloroform seemed to support the patient during the ordeal; and the writer has several times seen soldiers within a brief period after amputation for extensive gun-shot wounds, and restoration to consciousness, calmly subside into natural and refreshing sleep. One reason for not using chloroform in the Inspector-General's caution was, that the smart of the knife is a powerful stimulant; but "pain," it has been remarked by a great Surgeon, "when amounting to a certain degree of intensity and duration, is itself destructive;" and there can be little doubt that the acute pain of surgical operations, superadded to the pain which has been endured in consequence of severe gun-shot fractures, has often, where chloroform has not been used, intensified the shock, and led to fatal results. In civil surgery, statistical evidence has demonstrated that the mortality after surgical operations has lessened since the use of chloroform; and it is believed the same result would be shown, if opportunity existed, in army practice. In the report of a case in the Crimea, instancing, perhaps, the greatest complication of injuries from gun-shot of any which recovered, Dr. Macleod remarks casually in his *Notes*, p. 265, "This amputation was of course done under chloroform, otherwise it is questionable whether the operation could have been performed at all, the patient was so much depressed." Mr. Guthrie, in the Addenda to his *Commentaries*, remarked, from the reports and cases which had reached him, that chloroform had been administered in all the Divisions of the army save the Second, and had been generally approved; and that the evidence was sufficient to authorise Surgeons to administer it even in such wounds as those requiring amputation at the hip-joint. The late Director-General amputated in three instances at the hip-joint after the battle of the Alma under chloroform,—two on the 21st, and one on the 22d September,—and all these lived to be carried on board ship on the latter-named day, and two, as before stated, lived several weeks. The absence of increased shock from pain during the amputation very probably enabled these patients to withstand the fatigue of removal to the coast, and embarkation on board ship. With regard to the objection of occasional bad results, a recent estimate has shown that the probable proportion of all the deaths which have occurred from chloroform to the operations performed under its influence, exclusive of its use in midwifery, dental surgery, and private practice, has been one in 16,000; and as these accidents may equally occur during "minor operations," in army practice, as in civil life, it should be used or not at the option of the patient.

In respect to the danger of anæsthetics in the secondary operations connected with gun-shot wounds, Dr. Scrive's experience has led him to remark: "When consecutive amputation is rendered necessary by the gradually increasing debility of a wounded man from purulent discharges, chloroformisation takes place with the most perfect calm on the part of the patient;" and he classes its use under "chloroformisation de nécessité." The general rules followed in civil surgery must be equally applicable in these cases.

It must frequently happen in military practice that several operations have to be performed in rapid succession on the same person, from necessity of a speedy removal of the wounded; and, moreover, from the number of cases which are suddenly thrown on the care of the army Surgeons after a general engagement, it must frequently occur that the diagnosis of a case is more or less doubtful. In such instances the use of chloroform, by diminishing pain and preventing shock, and thus giving the opportunity of more accurate examination of parts, becomes particularly valuable in army practice. After the battles of Alma and Inkermann, when orders were given to remove the wounded as speedily as possible, the first-named consideration frequently occurred. The case of Sir T. Trowbridge is quoted by Mr. Guthrie. This officer had both feet completely destroyed by round-shot at Inkermann, and it was necessary to amputate, on one side at the ankle-joint, on the other in the leg: the use of chloroform enabled the two operations to be performed within a few minutes of each other with perfect success. The amputations were done by the late Director-General of the Army Medical Department. In illustration of the second casualty, the following, which happened to the writer at Alma, may be named. A man of the Grenadier company of the 19th Regiment had a leg smashed by round-shot. It was a question whether the fracture of bone extended into the knee-joint. Two superior Staff-Surgeons were near; a hasty consultation was held, and it was decided that the probabilities were in favour of the joint being intact. Amputation was performed, and the tibia sawn off close to the tubercle. It was then rendered evident that there was fissured fracture into the joint. As soon as the man had recovered from the state of anæsthesia, the necessity of amputation above the knee was explained to him, and he readily assented. This was shortly afterwards done, and the man recovered without any unusual symptoms, and was invalided to England. It is not likely, without chloroform, in a doubtful case of this kind, that the chance of saving the knee would have been conceded.

In the British army in the Crimea, chloroform was generally applied by simply pouring a little on lint. The chief objection against this in the open air is probably the waste which is likely to be occasioned. Dr. Scrive says it always appeared to him most advantageous to use a special apparatus, as well to measure exactly the doses, as to guarantee a proper amount of mixture of air; and that although he never saw a fatal result, he had several times seen excess of chloroformisation from the use of lint rolled up in the shape of a funnel. The instructions which he gave were, never to pass the stage of strict insensibility to pain, never to wait for complete muscular relaxation; and to this direction being carried out he attributes the fact that no death occurred from chloroform in the French army in the Crimea. In a recent article on anæsthetics in the *Medico-Chirurgical Review*, Oct. 1859, Dr. Hayward, of Boston, has strongly advocated the use of sulphuric æther above all other anæsthetics. The quantity required to produce anæsthesia—from four to eight ounces—would render the use of this agent almost impracticable in extensive army-operations in the field.

After-Usefulness of Wounded Soldiers.

The results of wounds unfit soldiers for military service in many ways, according to the nature of the wound, and the region in which it is inflicted; and the pensions consequent on their discharge entail heavy expenses of long duration on the country. It was hoped that the improvements in conservative surgery would have diminished the number of disabled soldiers as compared with former wars; but the corresponding improvements in the power and means of destruction, with other circumstances, have defeated this hope, and the returns do not show such to be the result. Even the cases where resections of the joints have been performed, and fractures united, which previously would have been treated by amputation, have rarely presented such cures as to render the men available for military service, though the preserved limb may still be of use in the work of civil life. Formerly, all men who thus became unfitted to perform any of the duties to which a soldier is liable were removed from the army; but, by an order from the Horse Guards of 1858, wounded soldiers, though rendered unfit for active service in the field, were directed to be retained for modified duty in such employments as they are capable of executing. The results of the increased practice of conservative surgery may, therefore, prove valuable to the public service, now that the opportunity of secondary employment is laid open. The reports from the hospitals in Italy show that during the recent campaign in that country, the practice of conservative surgery after gun-shot fractures has been very limited, and in the lower extremity has been almost wholly abandoned, early amputation being practised instead.

It is believed, that should England become again involved in war, a greater amount of systematic scientific observation will be brought to bear upon the subject of gun-shot wounds than circumstances have ever previously admitted. Hitherto, the majority of the younger medical officers of the army have found themselves, on the occasion of war, suddenly in possession of a large number of wounded officers and soldiers to treat, with only those general principles of surgery to guide them which they had originally obtained in their studies in civil hospitals and schools; but this knowledge, essential and absolutely necessary above all other as it is, has been long admitted in the first-class powers of the Continent, whose military experience is necessarily greatest, to be incomplete for this purpose. Now that an Army Medical School has been established in England, and that in it the large number of sick and wounded who annually return from all parts of the world—serving to illustrate, among other subjects, the consequences of wounds and of the surgical operations performed for them in all their varieties—will be turned to account, as well as the great collection of preparations in the Museum of the Army Medical Department, it is only reasonable to hope that the opportunities of study in these specialities which will be afforded to every medical officer at his entrance into the army will cause each individual, not only to be ready to apply at any moment all the improvements derived from experience and observation, up to the most advanced period, in this branch of the profession of surgery, but will also best prepare the members of the department for extending still further the sphere of usefulness which has been cultivated by their predecessors.

THOMAS LONGMORE.

INJURIES OF THE HEAD.

Wounds of the Scalp. Contusion of the Bone.

IT has been thought advisable, for practical purposes, to treat of these injuries together, as they are often combined in civil life; and what appeared a simple wound of the scalp is ultimately not unfrequently found to have been complicated by much more serious mischief—contusion of the bone.

Of the various forms of scalp-wounds occurring in daily life, wounds produced by heavy blows, or those in which flaps have been more or less extensively detached, are the most common. Such wounds are, for the most part, accompanied by bruising of the soft parts; but it not unfrequently happens that these bruised wounds of the scalp present the appearance of a clean cut, and look exactly as if they had been produced by some sharp instrument. These flap-wounds are more common about the scalp than in any other part of the body, and it is in this region, too, that the most extensive wounds of this kind are generally met with, the greater part of the skull being at times uncovered, and even the ears torn away.

Bruised wounds of the scalp are to be treated like common incised wounds, and in many instances they heal just as readily.

Neither is there, in the present day, any question as to what is to be done with flap-wounds of the scalp. After careful cleansing of both surfaces of the wound, the flap, however extensive, is to be replaced, and maintained in position by strips of plaster, compresses, and a bandage. Sometimes a suture, here and there, may be necessary; but sutures must be sparingly used about the scalp, and great care must be taken not to include any part of the occipito-frontalis.

Flap-wounds of the scalp, of the largest size, are not unfrequently healed within a few days. Occurring, as most of these flap-wounds do, by the rending of the loose cellular tissue under the occipito-frontalis, they carry with them a rich supply of blood-vessels; and hence the reason why these flaps so seldom slough, and why they so readily heal.

The bone of the skull being exposed makes no difference as to the plan of treatment; for flap-wounds, with extensive exposure of the bone, often heal without a single drawback, and that in cases where such a result appeared almost hopeless.

The wound may, however, not heal by first intention; and, under such circumstances, either granulations spring up from the surface of the exposed bone, or thin, almost imperceptible, scales of bone are thrown off, and union by second intention follows.

Hæmorrhage in scalp-wounds is seldom very troublesome. Both ends of the divided vessel can, for the most part, be readily secured, or pressure may be established on the main trunk, at some distance from the wound. In a wound of the lower part of the temporal fossa, hæmorrhage from the deeper vessels may, however, be very difficult to deal with; and in such a case, should the bleeding recur and become dangerous, notwithstanding all our local means, the question of applying a ligature to the external or to the common carotid artery may arise.

Wounds of the scalp, even of the most trifling nature, are not unfrequently followed by inflammation of an erysipelatous character, affecting sometimes the skin only, but much more commonly the loose cellular tissue under the occipito-frontalis muscle.

If erysipelas alone exist, the local treatment is to be of the simplest kind. The frequent lancet-puncturings, so strongly advocated some few years back, are not necessary; they are exceedingly painful, and they certainly do not lessen the duration of the disease.

Diffuse cellular inflammation of the scalp first shows itself by slight puffiness, without any redness of the skin, in the neighbourhood of the wound; and this local indication, if not ushered in, is soon followed, by general symptoms—feverishness and rigors. An outpouring of lymph subsequently takes place into the meshes of the loose cellular tissue, and then more or less induration and great thickening of the scalp, which, when cut into, presents a brawn-like appearance. Unchecked, this form of inflammation soon leads to extensive sloughing, and large portions of the cellular tissue are rapidly destroyed.

On the first appearance of puffiness around a scalp-wound, a free exit should be given to the effused fluid, and for this purpose the adherent lips of the wound ought at once to be separated. In large flap-wounds, however, it is seldom necessary to destroy all the adhesions; a free separation of the lips of the wound at different points is, in most cases, all that is necessary, and then a warm poultice or fomentations should be applied. Should the effusion spread notwithstanding, the system of free puncturing may be adopted with great advantage, and in the more threatening cases incisions will be absolutely necessary. In such cases, the essential point is that the knife should be carried freely down to the bone; and as to the length of the incision, it is better that it should not be extensive. Limited incisions answer every purpose; and they lessen the danger of hæmorrhage, which, in persons of broken-down constitutions, may become a matter of vital importance.

Such incisions, provided the general condition of the patient be good, will, in the great majority of cases, prevent any very extensive sloughing of the cellular tissue of the scalp. In some cases, however, extensive sloughing of the cellular tissue does take place, and the tendon of the occipito-frontalis muscle and the pericranium may become involved; but the scalp itself very rarely perishes. This is easily accounted for by the peculiar distribution of the arteries in this region, the trunks and main branches of which here all lie immediately under the skin. And occasionally, to add to the difficulties, a large arterial trunk is laid open by ulceration, and hæmorrhage ensues, the source of which, owing to the blood accumulating under the detached scalp, it may at first be difficult to make out.

With proper management, it is surprising, notwithstanding all this, to see how well a case of this kind may do. The sloughs separate, but the extensively-detached scalp, loose and bag-like, being kept alive by its vessels, soon re-adapts itself to whatever structures may be left, and ultimately becomes firmly adherent to them.

The general treatment, both in erysipelas and in diffuse cellular inflammation of the scalp, must be of the most generous kind. Tonics and diffusible stimulants must be resorted to at a very early period; and it will be advisable also freely to administer such stimulants—brandy, wine, &c.—as the patient may have been accustomed to.

A simple blow on the head, with or without a scalp-wound, may sooner or later lead to mischief about the bones of the calvaria. Sometimes the diseased action thus set up ends in hypertrophy of the bones; this may go on for years, and the calvaria thus become enormously thickened. Of this there is a well-marked example in the Museum of the Royal College of Surgeons. In the vault of this skull the bones are, in some parts, no less than eleven lines in thickness.

Again, the diseased action thus set up may lead to caries or necrosis of the calvaria. And here the disease may be limited to the original seat of the injury, or it may spread far and wide, affecting either one or both tables of the bones. In some cases even, the mischief has spread over the whole vault of the skull. Specimens of extensive disease, limited to the outer parts of the calvaria, and caused by a simple blow, exist in the Museums of the Royal College of Surgeons and of St. George's Hospital. Dr. Abercrombie* mentions a case in which the inner table alone of the calvaria was thus extensively destroyed. In Norris's case† the disease attacked both tables of the whole of the calvaria, and extended even as far as the foramen magnum. The skull is now in the Museum of the Royal College of Surgeons.‡ Mr. Drummond's case§ affords another example of extensive destruction of the vault of the skull, originating in a blow on the head. But of cases of this kind, Saviard's|| is the most extraordinary. In this case, two years after a blow on the head, the whole skull-cap came bodily away.

The treatment of such cases differs in no wise from that of caries and necrosis of the skull arising from other causes. Matter pent-up under the scalp must be let out, and the loose pieces of bone removed; and occasionally, but very rarely, the application of the trephine may become necessary. But in this we cannot be too cautious, notwithstanding the brilliant results obtained in former times by the extensive application of this instrument.

In the above cases, the mischief in the bone was chronic; but a blow on the head, with or without a scalp-wound denuding the bone, may be followed by inflammation of an acute character, the starting-point of which is in the diploë, where the blow is followed by an extravasation of blood, or a breaking-down of the cancellous tissue; the compact tables suffering but little from the injury.

Inflammation of the diploë, in connexion with such a contusion, is fraught with danger. The inflammation may at any moment spread to the internal table of the bone, and from thence to the membranes of the brain; and, involving some of the veins of the

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* *Diseases of the Brain*, 2d edit. p. 189.

† *Trans. of the Med. Soc. of London*, vol. i. p. 168.

‡ *Pathol. Cat.*, 1847, vol. ii. p. 115. It is entered as a specimen of tuberculated syphilitic disease; but this is an error.

§ *Med.-Chir. Trans.* vol. xxxiv. p. 103.

|| *Rec. d'Obs. Chir.*, 1762, p. 386.

diploë, it may also lead to purulent infection, and secondary deposits in various parts of the body.

The patient having recovered from the immediate effects of the injury, may for a time appear to be in perfect health; and thus matters generally go on for a fortnight or three weeks, when a change, slight at first, takes place. Where there is a wound, it loses its healthy aspect, and this is accompanied by feverishness and pain in the head; then follows a spontaneous secession of the periosteum; and the bone, if denuded, becomes dry and discoloured. Such are the first indications of mischief; and now, should the inflammation spread from the internal table of the bone to the dura mater, this membrane secedes from the affected bone, and its outer surface is covered with lymph or pus. Thus far the mischief is circumscribed; but when the inflammation reaches the parietal arachnoid, it spreads more or less over the free surface of this membrane, and soon involves the visceral layer of the arachnoid, the pia mater, and the corresponding surface of the brain. Meanwhile the symptoms become more and more marked,—increased feverishness, repeated rigors, intense pain in the head, sickness, drowsiness, occasional wandering, coma, and sometimes paralysis.

In all this, it is held that the affection of the bone is the essential element; and such no doubt is the rule. It was, however, taught by Pott,* that the affection of the bone was only secondary to that of its membranes.

In the treatment of these cases, the first question is, whether the inflammation likely to arise from a contusion of the skull-bone can be prevented. Free blood-letting at the onset of the symptoms would, it was at one time thought, prevent further mischief; and by Pott,† especially, great success was attributed to this plan of treatment. But, as I shall hereafter explain, these successful cases were, I believe, instances of inflammation beginning, not in the dura mater, but in the visceral layers of the membranes of the brain, and dependent upon what is commonly called concussion. It is no doubt right, as soon as inflammatory symptoms make their appearance after a blow on the head, to have recourse at once to antiphlogistic remedies; but the prospect of the benefit likely to be derived from our treatment must depend upon the cause of the inflammation. In inflammation dependent upon concussion of the brain, antiphlogistic remedies will, in the great majority of cases, be of very great use; but in inflammation beginning in the diploë and spreading to the dura mater, they will be of little or no avail; and hence the reason why we so commonly find these cases running their course, notwithstanding blood-letting, mercury, &c.

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* *Inj. of the Head*, 1768, p. 39.

† Ibid. p. 55.

The increase of the symptoms leads to the question of trephining in such cases.

Trephining for matter between the bone and the dura mater appears, in Pott's hands, to have been a most successful operation. Blow on the head—subsequent secession of the pericranium—pain in the head—fever—rigors—application of the trephine—evacuation of matter—cured. Such is the history of the majority—five out of eight—of the cases in which Pott applied the trephine.* But no such success has attended the practice of other Surgeons. On the one hand, the dura mater has been found, over and over again, perfectly sound in cases where the trephine has been applied for precisely similar symptoms; and, on the other hand, although matter may have been found between the bone and the dura mater, the patient has nevertheless died. I have repeatedly seen the trephine applied under such circumstances, and matter evacuated, but without any permanent benefit. Indeed, the successful issue of a case of trephining for matter between the bone and the dura mater is, I believe, all but unknown to Surgeons of our own time.

Pott was successful because the inflammation in the majority of his cases happened to be strictly limited to the outer surface of the dura mater; and this Pott thought was frequently the case: but further experience has proved that this strict limitation of the inflammation is quite exceptional. In every case of contused bone in which I have found inflammation on the outer surface of the dura mater, I have also found inflammation on the free surface of the arachnoid.

With this all-but constant diffuse suppuration of the arachnoid which accompanies inflammation of the dura mater in connexion with contused bone, there is, then, but very little hope of doing any good by trephining; but as the operation is the only chance left, we must not lay the trephine aside altogether, as some Surgeons have done in these cases.

In order, however, that we may avoid the risk of applying the trephine in cases where the dura mater is healthy, we must be especially careful to operate in those cases only where, in addition to fever and rigors, and to the local signs about the bone, there are also well-marked brain-symptoms—coma, and, better still, hemiplegia. With such a train of symptoms, lymph or pus has invariably been found between the bone and the dura mater in all the cases in which I have seen the skull perforated.

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* Op. cit., pp. 63-107.

Now and then, but very rarely, the matter in the cavity of the arachnoid, instead of being diffused, is limited by lymph gluing together the two layers of the serous membrane; and thus is formed a perfectly circumscribed abscess. In such cases, after the skull has been perforated, the dura mater bulges into the trephine-hole; and it is tense, and without any pulsation. Here there is no doubt as to what is to be done. The dura mater must be cut into, in order that the matter be evacuated. It was by thus incising the dura mater that Guthrie* saved the life of one of his patients. In Roux's case,† after the removal of the bone by the trephine, a large hole was found in the dura mater; this gave free vent to a collection of matter circumscribed within the cavity of the arachnoid, and the patient got well. And Mr. Dumville's recent case affords another striking instance of circumscribed suppuration within the cavity of the arachnoid, and similar in some points to M. Roux's. The girl, Mary Driskell, was admitted into the Manchester Royal Infirmary for a scalp-wound, and denudation of the frontal bone. The symptoms first made their appearance three weeks after the accident, and led to the supposition that matter had formed between the bone and the dura mater. The trephine was applied: no matter was found on the dura mater, which, however, was whiter and thicker than usual, except at one point of the margin of the trephine-hole, where there was a red spot; this proved to be a small hole in the dura mater, into which the flat end of a probe was passed, whereupon a quantity of most offensive matter spirted out. The symptoms were relieved, and the patient ultimately got well.‡

But of all the complications incident to the slighter forms of injury of the head, none is so fatal as purulent infection, which may arise out of a simple wound of the scalp, or, as is much more frequently the case, be connected with contusion of the skull, followed by inflammation and suppuration of the diploë, in which some of the large and numerous venous canals of the bone have become implicated.

In purulent infection arising out of either of these causes, the brain and its membranes may remain perfectly healthy. With contusion of the bone, however, it much more commonly happens that purulent infection is associated with intra-cranial suppuration.

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* *Inj. of the Head*, p. 127. † *Arch. génér. de Méd.* 1830, vol. xxiv. p. 280.

‡ *Brit. Med. Journ.* 1858, vol. ii. p. 743.

The frequent association of purulent infection with slight injuries of the head must be kept constantly in view; for its symptoms sometimes resemble very closely those of intra-cranial suppuration; so much so that, unless on our guard, we may be misled, and especially in the early stages, when there are as yet no signs of mischief in other parts of the body. And the diagnosis will be still more difficult, if not altogether impossible, in those cases where there is matter between the bone and the dura mater, as well as purulent infection.

For a long time the liver was thought to be the spot in which secondary abscesses occurred in connexion with an injury of the head; but further experience has proved that matter may, in such cases, form in any and in every part of the body, and that the lungs are, of all parts, the most frequently thus affected. Out of eighteen cases, in all of which the purulent infection occurred either after a wound of the scalp or a contusion of the bone, I found the lungs studded with secondary abscesses in thirteen cases, and the liver in three; and out of these three the liver alone was affected in one case only, and in the other two the lungs were affected as well as the liver. In purulent infection, the serous membranes are also frequently the seat of secondary inflammations; and here we shall also find that the serous membranes of the chest are much more frequently affected than that of the belly. Thus, out of these eighteen cases, the pleura was extensively inflamed in no less than in twelve cases, and the peritonæum in one case only. In some of these cases the inflammation was confined to the serous membrane; but in most of them the pleura and the lung were both affected. In the limbs, the joints are not unfrequently filled with matter, and large collections of pus occur at different points in the cellular tissue. Even the skin, as is now well known,* may become affected in purulent infection. Now and then, but very rarely, the skin is studded with small deposits of matter, looking exactly like the pustules in a bad case of small-pox. Of this I have seen only two or three instances. In other cases, the skin is covered with sundry patches of a purple hue, resembling the circumscribed patches of congestion commonly seen about the lung in an early stage of the disease; and in other cases again, a large portion of the skin is suddenly stricken with mortification, which proceeds very rapidly. Of this I have seen several instances.

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* Henry Lee, *Infl. of the Veins, &c.*, 1850, p. 53.

A careful examination of the venous system of the head shows, in some cases, the veins of the scalp filled with pus: in other cases, pus is found in large quantities in the veins of the diploë; so much so that, in trephining for matter between the bone and the dura mater, I have several times seen pus streaming out of the large venous canals of the diploë; and within the skull, the veins on the surface of the hemispheres are sometimes loaded with pus, and so too, and much more commonly, is the superior longitudinal sinus.

In purulent infection, surgery can do nothing unless the pus happens to be altogether effused into parts which are accessible, such as the joints, or the cellular tissue. Of late years, however, M. Chassaignac has proposed that we should once more resort to the trephine as a preventive; that we should cut out the contused piece of bone in which suppuration is likely to take place, and thus remove the starting-point of the disease. But the objections to this proposition are so obvious, that few Surgeons will, I think, venture to put it into practice.

And, medically, our only hope is in keeping up the general strength by all possible means, bearing in mind that cases do now and then occur in which recovery takes place, notwithstanding clearly-marked symptoms of purulent infection, — cases in which inflammation of the lung has existed, and in which large collections of matter have burst, and been brought up.

In dealing with purulent infection,—in dealing, too, with erysipelatous and diffuse cellular inflammation of the scalp,—we must also bear in mind, that disease of the kidneys may possibly be at the bottom of the evil. Patients affected with Bright's disease are especially liable to extensive inflammations of the cellular tissue, just as well as of the serous membranes. And in this condition of the kidneys one not unfrequently sees diffuse cellular inflammation beginning around a slight wound of the scalp, and rapidly spreading over the head and face, and down the neck into the mediastina. In such cases, too, one or more of the serous membranes may also be filled with sero-purulent fluid.

EXTRAVASATIONS OF BLOOD.

Blood may be extravasated in the soft parts external to the bone; in the bone itself; between the bone and the dura mater; within the arachnoid; in the pia mater; in the structure of the brain, or in its ventricles.

In the parts external to the bones. The extravasation may take place between the skin and the occipito-frontalis muscle, in the loose cellular tissue under this muscle, or beneath the periosteum. In either of these situations the extravasation may be infiltrated into the tissues, or enclosed in a cavity more or less well circumscribed.

Infiltrated. In the very dense cellular tissue between the skin and the occipito-frontalis muscle, the blood presents itself as a hard unyielding lump; but beneath the muscle it spreads through the meshes of the loose cellular tissue, and gives rise to a crackling sensation.

Enclosed in a cavity. The extravasation may form either a prominent tumour, with a soft centre and a hard base, or a diffused swelling, with boundaries gradually lost in the surrounding tissues. Diffused swellings of this kind occur as well under the pericranium as in the loose cellular tissue above this membrane; and in either case the collection of blood may be such as to cover over the whole surface of the calvaria.

The fluid in these collections varies very much at different periods: it may be blood, arterial or venous, in a more or less fluid state; or a thick viscid fluid, of a dark, bistre colour; or bloody serum with clots, or serum alone. And the cavity containing the fluid, formed at first by the surrounding tissues only, is subsequently lined by a perfectly-formed membrane, possessing all the attributes of an original serous tissue, and to this is sometimes added a thick deposit of fibrine disposed in layers, such as are found in an aneurism.

The diagnosis of extravasations of blood external to the bone is, for the most part, easy; but the extravasation with a hard ridge round its base and a soft centre may lead to some difficulty. It has been mistaken for a fracture with depression, and that by some of the most practical Surgeons; and all the more readily may such an error occur when the swelling, in connexion with a lacerated artery, pulsates.

In the treatment of these external extravasations of blood there is generally but little to be done; in due course of time the blood is absorbed. But it occasionally happens that the collection persists, and even increases in size, and under such circumstances it may be necessary to evacuate the fluid. This must be done by a small puncture, after which compression is to be established over the whole surface of the swelling. In large collections, such puncturings may have to be repeated several times; and in an encysted collection of large size, should the fluid be of a serous character, and recur again and again, an iodine-injection might be thrown into the pouch. And when suppuration occurs, the pouch must here, as every where else, be at once freely laid open.

Extravasations of blood *in the diploë*, and the consequences to which they may give rise, have already been dwelt upon in the previous section.

Extravasations of blood *between the bone and the dura mater* may proceed from the small vessels passing from the one to the other, or from some of the large vessels lodged in the grooves on the inner surface of the skull. The former extravasations, generally speaking, are of small size; but the latter may be very extensive, widely separating the membrane from the bone over the greater part of one side of the skull. Of the large extravasations, the most frequent by far is that from the middle meningeal artery. Out of thirty-one cases of fracture of the skull, accompanied by extensive extravasation, the blood had proceeded from the middle meningeal artery or its branches in twenty-seven cases. Occasionally the extravasation proceeds from one of the large venous sinuses, and of these the lateral is more commonly lacerated than any other sinus. One of the most extensive extravasations of blood between the bone and the dura mater which I have seen, proceeded from a rupture of the lateral sinus, just as it turns under the petrous portion of the temporal bone.

The spot usually referred to in extravasation of blood from the middle meningeal artery is the anterior-inferior angle of the parietal bone; but extensive extravasations may occur from this vessel or some of its branches over pretty nearly the whole of the lateral surface of the skull. In fractures involving the middle fossa, the most common of all the fractures of the base of the skull, this vessel may be torn across in any part of its course between the foramen spinosum and the anterior-inferior angle of the parietal. And in the middle fossa of the skull, it frequently happens that the middle meningeal artery divides itself into two large branches of equal size, one proceeding to the anterior-inferior angle of the parietal, and the other passing much more posteriorly, which send large ramifications over the whole of the parietal and the corresponding parts of the frontal and occipital. A fracture running across any of these large branches may give rise to an extensive extravasation of blood.

A collection of blood between the bone and the dura mater differs widely from extravasations of blood in other parts of the cranial region. It always presents itself in the shape of a hard granular mass, breaking down with great difficulty, even under heavy pressure, and adhering most firmly to the parts between which it is lying; separating, more or less widely, the dura mater from the bone; and pressing upon the brain itself, sometimes to such an extent as to produce a large cup-like cavity on its surface.

The changes likely to take place in such an extravasation, should the patient live, are very few. It has been doubted whether blood between the bone and the dura mater could be absorbed; but in one instance, where the patient lived for a few weeks after the accident, I found thus situated a small hard clot, which had already lost the greater part of its colouring matter, and was undergoing the process of absorption. As for these collections becoming encysted, of this I know no well-authenticated case; neither have I ever seen, even after several days, any thing approaching to the formation of a cyst.

The symptoms dependent upon an extravasation of blood between the bone and the dura mater vary very much. In small extravasations the symptoms may be but slightly marked; and in a slow outpouring of blood, the brain may have time to accommodate itself to the pressure. In well-marked compression, however, the patient is generally perfectly insensible; the breathing is slow and laboured, oftentimes stertorous, and sometimes accompanied by a peculiar whiff at the corner of the mouth; the pulse too is slow and laboured; the pupils may be either contracted or dilated, and the eye fixed and insensible to light; there is paralysis, more or less complete, of one side, with retention of urine and involuntary discharge of fæces.

It unfortunately happens, however, that the symptoms of compression bear at times a very close resemblance to the symptoms of concussion and of contusion of the brain, so much so in some cases that it may become a difficult matter to decide as to the exact nature of the injury. But however alike the symptoms of compression and of concussion may at times be, there is this marked difference between the two states,—in concussion, the effects are instantaneous; and in compression from extravasated blood, some little, it may be a very short, time elapses before the symptoms manifest themselves; in the former, also, the symptoms gradually pass off, but in the latter they become more and more marked.

In the year 1839, a man was struck with a spade just over the anterior-inferior angle of the right parietal; and when he came to St. George's Hospital a few minutes afterwards, a compound fracture, with depression of a small piece of the skull, was detected, but there were no cerebral symptoms whatsoever. Shortly afterwards, however, the patient became heavy and stupid; and coma was gradually supervening, when Mr. Keate arrived, and at once proceeded to remove the depressed bone, whereupon a jet of blood spirted out from a large branch of the middle meningeal artery, and all the symptoms of compression were immediately relieved.

In this case there was no doubt as to the symptoms being wholly dependent upon the extravasation of blood which was going on under the bone; there was no injury of the brain itself, and the interval between the blow and the symptoms was clearly marked. But had concussion of the brain existed, the outpouring of blood might have taken place when the patient was insensible, and then we should have lost our most valuable means of diagnosis, the "interval of time." Again; in civil hospitals, nearly all large extravasations of blood between the bone and the dura mater coexist with contusion and laceration of the brain-substance. The post-mortem records of St. George's Hospital show that within the last few years there have been twenty-five cases of large extravasations of blood between the bone and the dura mater, in all of which the brain was more or less extensively lacerated.

Injuries of such a compound nature easily explain the difficulties as to diagnosis, and the reason why the trephine is so seldom applied nowadays for extravasated blood; and why also, when resorted to, the operation so seldom succeeds.

But cases now and then occur in which there is no doubt as to the propriety of applying the trephine, and in which its application is followed by the most signal success. Of this Mr. Keate's case above mentioned affords a striking illustration; and in the year 1842 there was another case of the same kind, at St. George's Hospital, under the care of Mr. Tatum, and in which the operation was equally successful.

In other cases, the history of an extravasation of blood may be perfectly clear, but there may be no local sign as to the seat of the injury, and perhaps even nothing to guide us as to which part of the head was struck. Under such circumstances, operative interference is out of the question, unless paralysis be present. But should paralysis exist on one side, we may infer that the extravasation of blood is, at any rate, on the opposite side; and then an incision over the lower part of the corresponding parietal is warranted; for a fissure of the skull may thus be laid bare, the trephine applied, and the patient saved.

In the cavity of the arachnoid, traumatic extravasations of blood occur much more frequently than in any other part within the skull. Such extravasations are, indeed, very common, and much more so than is usually supposed. Blood is found in the cavity of the arachnoid in the great majority of severe injuries of the head; and I have frequently found it also in cases where the injury has been a trifling one, and that without any apparent lesion either about the brain or its membranes.

In the majority of instances the blood corresponds to the cerebrum, rarely to the cerebellum, and still more rarely to the medulla oblongata.

Blood extravasated within the cavity of the arachnoid undergoes, in the course of time, various changes, which it is important to notice.

In the earlier stages, the blood, when coagulated, is flattened and moulded, membrane-like, upon the parts between which it lies. In this shape I have frequently found large quantities of blood spread over and capping both hemispheres of the brain. After a time the colouring-matter of the blood disappears, more or less; and thus are formed the membranes, of different hues, which are found within the arachnoid after an injury of the head. In slight extravasations, all that may be found after a few days is a mere film, so delicate and so slightly tinged as easily to escape notice.

In the great majority of cases, the false membrane is firmly attached to the parietal arachnoid; its free surface, perfectly smooth and polished, presents the appearance of a serous tissue; and its structure is throughout plentifully supplied with blood-vessels, which may be readily seen with the naked eye. I have met with all these characters, well marked, three-and-twenty days after an injury.

These blood-membranes, at first soft and pulpy, may subsequently become leathery, fibrous, or even cartilaginous; and under such circumstances, they have been referred to and described as diseases of a very different character, and especially chronic inflammation.

Extravasations of blood into the cavity of the arachnoid not unfrequently give rise to appearances of a most deceptive character. The blood, glued to the parietal arachnoid, and covered over by a thin, polished, serous-like membrane, looks exactly as if the extravasation had taken place between the dura mater and its arachnoid, and widely separated these membranes from each other. But the true nature of these cases has of late years, and especially by the French pathologists, been clearly made out.*

Instead of forming simple layers of membrane, the blood, if the extravasation is a large one, may in the course of time give rise to the formation of a large perfectly-closed bag, in which are contained the more fluid parts. Such blood-cysts may contract more or less extensive adhesions with both layers of the arachnoid; but they are, for the most part, glued to the parietal arachnoid only; and, in some rare cases, they have been found lying perfectly loose in the cavity of the arachnoid. In M. Leriche's case,† the blood-cyst lying loose in the cavity of the arachnoid was an inch and a half in width; and it covered over the greater part of the upper surface of the left hemisphere, where it had imbedded itself. In Dr. Quain's case,‡ the cyst fell out of the cavity of the arachnoid when the dura mater was incised; and measuring in length seven inches and a half, and in width one inch and a half at its broadest part, this cyst had formed a corresponding depression on the upper surface of the cerebral hemisphere. The preparation is now in the Museum of St. George's Hospital.

When glued, as they commonly are, to the parietal arachnoid, these blood-cysts are thoroughly supplied with blood-vessels; and thus organised, these cysts possess all the physiological characters of an original serous membrane. They secrete; they absorb; they have been found filled with clots of fibrine and blood-tinged serum; sometimes they contain serum alone, of various colours; and oftentimes in the cavity of the same cyst are found clots of blood of various colours, some recently effused, and others of long standing.

When the cyst is a large one, it presses upon the corresponding part of the brain, the convolutions of which become flattened, or slightly depressed, presenting a cup-like surface, and the corresponding ventricle is contracted. The pressure of the cyst, in long-standing cases, diminishes the thickness of the bones; and, in some cases, when formed in early childhood, such cysts have been known to lead to bulging of the bones outwards.§

There are no symptoms which will enable us clearly to diagnose an extravasation of blood into the cavity of the arachnoid. If slight, such an extravasation may be followed by no symptom whatsoever; and, even in larger quantities, when spread out in membranous layers, the blood may produce no very decided symptoms of compression; and most frequently, connected as these extravasations are, in the great majority of cases, with some severe injury of the cerebral substance itself, the symptoms of one lesion are mixed up with, or totally masked by, those of a very different nature.

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* Prescott Hewett *On the Ext. of Blood into the Cavity of the Arach.*, *Med.-Chir. Trans.* vol. xxviii. p. 45.

† *Bull. de la Soc. Anat. de Paris*, t. x. p. 55.

‡ *Trans. Path. Soc. Lond.* vol. vi. p. 8.

§ *Lancet*, 1846, vol. i. p. 416.

But should symptoms of compression follow a traumatic extravasation of blood in the cavity of the arachnoid, they will be the same as those of a collection of blood upon the outer surface of the dura mater; and a Surgeon may thus be led to apply the trephine under the supposition that the blood is in this situation.

And now, supposing the trephine to have been thus applied, and no blood found between the bone and the dura mater, still the blood in the arachnoid may chance to lie immediately under the spot, and the dura mater, of a blue colour, may bulge into the trephine-hole. Under such circumstances, blood in the cavity of the arachnoid has several times been let out, and the patients saved. When, however, there are no indications of the blood in the arachnoid being under the trephine-hole, there is nothing to justify the Surgeon in proceeding further.

Traumatic extravasations of blood in the cavity of the arachnoid sometimes give rise to a permanent affection of the brain.

In Dr. Quain's case, above cited, in which a large blood-cyst was found loose in the cavity of the arachnoid, the injury was followed by constant pain in the head, great irritability of temper, despondency, and subsequently by fits, which recurred from time to time. In Mr. Fisher's case, published by Mr. Hancock,* the patient, a young gentleman, became insane after a violent blow on the head from a cricket bat or ball, and in this state he remained, with occasional lucid intervals, for fifteen years; and all that was found after death was an enormous encysted collection of blood in the cavity of the arachnoid. And in Foville's† and Blandin's‡ cases, both of old soldiers in whom severe injuries of the head were followed by insanity, large collections of blood were years afterwards found encysted in the cavity of the arachnoid.

Traumatic extravasations of blood *in the pia mater* differ in many respects from those in the cavity of the arachnoid. They certainly occur less frequently, and they very rarely exist without some laceration of the brain-substance. Beneath the arachnoid, an extravasation of blood spreads into parts far away from the original seat of the injury, and the whole cerebellum and spinal marrow may thus be covered with blood proceeding from a laceration of the cerebrum only. In the pia mater, too, an extravasation of blood never, as far as I am aware, gives rise to encysted collections such as those which have been described in the cavity of the arachnoid.

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* *Lancet*, 1846, vol. i. p. 416.

† *Dict. de Méd. et de Chir. Prat.* t. xi. p. 407.

‡ *Anat. des Régions*, 2ème éd. 1834, p. 36.

It was at one time thought that these wide-spread extravasations of blood in the pia mater were apt to produce more urgent symptoms than those collections of blood in one mass which give rise to a less general pressure. But further experience has not confirmed this opinion; and it is now admitted that there are no symptoms by which an extravasation of blood in the pia mater can be recognised. Neither is there any possibility of these extravasations being let out, even supposing the dura mater to have been laid open. The constant infiltration of the blood in the pia mater precludes any such fortunate result.

Injuries of the head sometimes give rise to large extravasations of blood *in the structure of the brain*, and occasionally, too, the ventricles are found filled with blood after injuries of this kind. But in dealing with such cases great caution is necessary, in order to avoid, if possible, mixing up cases of apoplexy with those of traumatic effusions. An accident coexisting with an extravasation of blood in the cerebral substance does not necessarily imply cause and effect; the previous condition of the brain, or the outpouring of blood from diseased vessels, may, in fact, have been the cause of the accident. There is no doubt that many a case reported as one of traumatic effusion of blood in the brain was simply a case of apoplexy.

Minute extravasations of blood in the brain will find their appropriate place in the subject of CONTUSION OF THE BRAIN.

Collections of blood in the brain, or in its ventricles, the result of an accident, may run through the numerous and well-known changes of a simple apoplectic effusion. But such changes seldom, however, take place in traumatic extravasations, which are generally rapidly fatal, being, as they are for the most part, associated with other severe lesions of the cranial contents.

The symptoms of a traumatic extravasation of blood into the brain are the same as those of an apoplectic effusion. And the treatment, too, must be precisely similar. It, as well as all other treatment of intra-cranial extravasations, not admitting of operative interference, must be purely medical.

Fractures of the Skull.

These fractures may, for practical purposes, be conveniently divided into fractures of the vault, and fractures of the base, of the skull.

Fractures of the vault. In the vault, most of the fractures are direct; the bone gives way at the spot which was struck, and the result may be simply a fissure, or the bone may be broken into fragments.

The fissure is most frequently not limited to the seat of the injury; sometimes it spreads through various bones, and oftentimes reaches from the vault into the base.

The comminuted fracture is much less apt to spread; produced by a more or less concentrated blow, such a fracture is for the most part limited to the seat of the injury.

The comminuted fracture and the fissure may coexist, and this especially in cases of a heavy blow acting on a large surface.

Fractures of the vault may be limited to the outer or to the inner surface of the skull; but such fractures by far most commonly extend through the whole thickness of the bone. And the broken bone may either retain its proper level, or be driven outwards or inwards.

The displacement outwards very rarely happens; there are, however, two specimens of it in the Museum of St. George's Hospital. In both specimens, a piece involving the whole thickness of the bone, having been detached on three sides, is bent outwards, and thus raised two or three lines above the level of the skull: the fragment is, however, immovable, as it is still connected at one side to the surrounding bone, the external table of which is, at this part, only partially fractured; the appearances may, in fact, be said to resemble the lid of a box partially open. In one instance, the injury was produced by a chisel falling from a great height on to the head; and in the other, the patient, in a fall from a great height, struck his head upon some iron railings, one of which penetrated the skull.

The displacement inwards is of very common occurrence. The external table alone may be driven down; and this may happen in any part of the vault, but especially in the region of the frontal sinuses, where the depression may be very extensive, without any injury of the inner table. The inner table alone may be broken and depressed, without a trace of injury about the outer parts of the bone. Cases such as these are, it is true, very rarely met with; but extensive splintering and depression of the inner table not unfrequently exist with some slight injury of the outer table. In the Museum of St. George's Hospital there is a skull-cap with a comminuted fracture of the inner table with extensive depression, and in the outer table corresponding to this there are merely some slight cracks. And in another preparation in the Museum of St. George's Hospital, with splintering and depression of the inner plate alone, there is a simple clean cut, of an inch long, through the outer layers of the bone: the boy had fallen out of a cart, and no doubt the bone was cut by some sharp piece of stone lying on the road. In his remarks upon this important subject, it was to sabre-cuts that Mr. Guthrie* referred especially; but such appearances about fractures of the skull are by no means uncommon in civil hospitals. A smart blow inflicted on the skull by a more or less pointed instrument—a nail, the corner of a brick, a piece of flint, the angle of a slate—may produce such a fracture. M. Denonvilliers† presented to the Société de Chirurgie de Paris a specimen of this kind, in which the injury had been produced by a slate falling on the head. A case is also described by Mr. Benjamin Phillipps,‡ in which a large fragment, about two inches and a half long, was found completely detached from the inner table, and sticking in the dura mater; in the outer table was a clean cut made by a flat-iron or shovel. In Samuel Cooper's case§ the injury was caused by a nail projecting from a door which had fallen upon the patient.

Fractures with depression involving the whole thickness of the bone present some varieties deserving of notice. There may be, as in a specimen in the Museum of St. George's Hospital, a single line of fracture extending some distance, with an extensive over-riding of one side of the fracture. A very common form of fracture with depression is that in which an oval piece of bone is not only driven down, but split longitudinally in two fragments which slant towards each other, the depression being much greater at the centre than at the circumference. With such appearances on the outer surface, the fracture of the inner plate is much more extensive and much more irregular. A specimen in the Museum of St. George's Hospital affords a strongly-marked instance of this form of fracture, of which I have seen several cases. Such a fracture is commonly produced by some heavy body with a sharp margin applied with great force, —a quoit, a horse-shoe. But perhaps the most ordinary form of fracture with depression is that in which several fragments, more or less of a triangular shape, have their points extensively driven down and firmly wedged into each other, whilst their bases still remain on a level with the surrounding bone. Taken as a whole, the broken portion is here, too, almost always of an oval shape, and cracks and fissures involving only the outer table are frequently found disposed around the depressed piece. And here, too, whatever be the extent of the injury in the outer part, that on the inner side is much more extensive still. And so it is in all ordinary cases of fracture with depression.

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* *Inj. of Head*, p. 86.

† *Compend. de Chir. Prat.* t. ii. p. 578.

‡ *Med. Gaz.* vol. xxxiii., 1844, p. 129.

§ Erichsen, *Surgery*, 2d ed. p. 280.

The more extensive splintering and depression of the inner table of the skull is usually attributed to its greater density and consequent brittleness; but there is no doubt that the direction in which the force acts tends in some measure to produce these effects. Of this Mr. Erichsen* mentions a well-marked example. A man fired a pistol into his mouth, and the ball in passing out of the skull first struck the inner and then the outer plate of the vault. The result was, that the outer plate was much more extensively splintered than the inner one.

As to traumatic depression of the skull without a fracture, of this we have no well-authenticated specimen in the adult. And until such a preparation be brought forward, the existence of this form of injury in the adult ought not to be admitted. In young children with very pliant bones, it is just possible that such an accident might occur; but even here, in a well-marked depression, some of the bony fibres must have given way.

A wound of the integument leading down to the bone may accompany every variety of fracture of the vault. And in these compound fractures, the injury of the bone is very much more frequently strictly limited to the seat of the blow than it is in cases of simple fracture. Out of twenty cases of compound fracture of the vault, the injury of the bones was thus strictly limited to the seat of the blow in eight cases; in six of which the injury was produced by heavy blows, falls, or blunt instruments, and in two by sharp instruments. But out of fifty-six cases of simple fracture this strict limitation existed only in one single instance, and in this case the patient, having fallen off his coach-box, had struck his head against the ground.

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* Op. cit. p. 278.

Are there any signs by which we can in all cases recognise the existence of a fracture of the vault? No. Fissures involving the whole thickness of the vault of the skull constantly exist without ever having been suspected during life; and even an extensive and a comminuted fracture with great depression of the fragments may, and often does, escape notice, when the broken bone lies hidden under the temporal muscle or under a large extravasation of blood. And, on the other hand, an extravasation of blood may be mistaken for a fracture with depression, and so too may an abnormal depression of the skull. Such a depression may depend upon a congenital malformation, or be produced by absorption of the diploë and thinning of the tables, as sometimes occurs in the skull, especially in elderly persons.

Accompanied, however, by a wound leading down to the bone, fractures of the vault are, in general, easily detected; but even here appearances are sometimes deceptive, and sutures and vascular grooves have been mistaken for fissures. In some of these cases the error, no doubt, arose from carelessness; but an abnormal disposition of a suture may mislead the most attentive. And unless careful, even in compound fractures with depression, we may be led into error as to the exact condition of the inner plate of the bone.

There is, however, one sign indicative of fracture of the skull about which one would have thought that no mistake could possibly have occurred. But Maréchal* mentions a case in which the inspissated secretion of the frontal sinuses was mistaken for brain-substance, thought to be oozing out of a fracture in this region.

There is also on record† a singular instance of the appearances which may lead to an error in diagnosis as to a compound fracture of the skull. A woman was admitted into the Hôtel-Dieu with a wound in the temporal region, accompanied by profuse bleeding. A fragment of bone, several lines in length, was found deep in the wound and quite loose; this was removed, and the finger then passed through an opening, the circumference of which was unyielding. The case was at once thought to be one of compound fracture with separation of some fragments. But it was soon remarked by a by-stander, that the fragment of bone which had been removed was dry, and quite white, as if it had been macerated. This led to a more careful examination of the wound, and it was discovered that the supposed hole in the skull was nothing but a laceration of the temporal fascia, and the fragment, the innocent cause of the error, turned out to be simply a piece of bone which, lying on the ground, had been driven into the temple when the patient fell.

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* *Mém. de l'Acad. de Chir.* t. i. p. 247.

† Denonvilliers, *Thèse de l'App. du Trépan*, p. 16.

In the treatment of fractures of the vault of the skull are involved some of the nicest and most litigated points in the practice of surgery.

And first, as to lineary fracture or fissure. Unaccompanied by brain-symptoms, such fractures, even when compound, are not to be interfered with; the wound must be treated according to circumstances, and the case carefully watched for some time. Now and then a fissure of the skull, simple or compound, is followed by suppuration between the bone and the dura mater, the symptoms and treatment of which have already been noticed in the subject of "contusion of bone."

A few years back, and it was held that intra-cranial inflammation would, in all probability, follow a fissure of the skull; and hence the precept of Pott,* "that perforation is absolutely necessary in seven cases out of ten of simple undepressed fracture of the skull." But of inflammation following a fissure, one case only was met with in the wards of St. George's Hospital during a period of ten years, and in this case there was a wound leading down to the bone. The case, as in "contusion of the bone," went on well for upwards of a fortnight; and then, on the seventeenth day, came the symptoms of intra-cranial mischief, and death followed, notwithstanding the application of the trephine.

The principle of non-interference also holds good in a comminuted fracture, even with depression of the fragments, provided there be no wound of the scalp and no symptoms. It is now an established rule in our metropolitan hospitals that simple fractures of the skull with depression and without symptoms are to be left alone. The depression may be so marked as to be easily detected; and yet, so long as there are no symptoms, all operative interference, of whatsoever kind, is carefully to be avoided.

In such a case the recovery may be as rapid and as uninterrupted as if there had been no depression of the bone. But it must not be forgotten that such a depression may at any subsequent period lead to internal mischief of a serious nature; and the patient ought to be put upon his guard as to the risks which he for the future may be subjected to.

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* *Inj. of the Head*, p. 130.

But supposing there be a wound leading down to the bone in a depressed fracture without symptoms, what is to be done? Are we to operate at once, or not? The rule is, that we are to operate, and at once. Compound fractures of the skull with depression most frequently lead, as demonstrated by Sir A. Cooper and Sir B. Brodie,* to intra-cranial suppuration; and hence the rule laid down by these celebrated Surgeons, that we are to operate to prevent the impending mischief. To this rule, however, exceptions ought to be made. A slight depression, especially when it corresponds to the thicker parts of the injured bone, does not require an immediate operation. Neither does a deep in-driving of the bone over the frontal sinuses; but here it must be borne in mind that these sinuses do not begin to make their appearance until several years after birth. And should a compound fracture with depression chance not to fall under the notice of the Surgeon until some days after the accident, he ought, if there are no signs of inflammation, to abstain from operating; and all the more readily, if the depression is a broad one, and the fracture comminuted. In such an injury the patient sometimes recovers without any intra-cranial inflammation. But in the punctured fracture, in which sharp splinters of the inner table are driven down upon, or into, the dura mater, inflammation almost invariably arises sooner or later; and of all compound fractures of the skull, the punctured fracture is on this account the most dangerous, and the one which most imperatively calls for the use of the trephine. And closely allied to these punctured fractures are those in which a clean cut exists in the outer parts of the bone, with a more or less extensive splintering and depression of the inner plate. True it is that there may be some difficulty in such cases in ascertaining the exact condition of the bone; but we may be sure that the two plates are separated from each other, and the inner one splintered and depressed, if we can pass a probe sideways under the outer parts of the cut bone, and then feel the inner plate some distance deeper.

Sometimes, in these compound fractures of the skull, and especially in the punctured fracture, a sharp fragment of bone may be seen sticking in the brain. In such a case, one of Colles'* practical precepts is, that all attempts at removal should be postponed for a few days, in order that the cerebral substance around the fragment may have time to consolidate; but in such a case I cannot help thinking that it is better to try and remove the piece of bone, which sometimes, even, comes away readily enough. In these attempts the Surgeon should, however, be exceedingly careful; and should he find the fragment, notwithstanding all his care, sinking deeper into the brain, then there is no doubt that he ought at once to desist, and make no further attempt for a few days.

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* *Med.-Chir. Trans.* vol. xiv. pp. 401, 402.

In the fractures which we have been considering, operative interference may be, and often is, of essential service; but thus far we have dealt with the most favourable cases only—those cases in which the injury of the bone was not accompanied by brain-symptoms.

Passing now to those depressed fractures in which there are primary brain-symptoms, are we to operate in all such cases? If the fracture is a simple one, and the symptoms not very urgent, we may postpone the operation, and see what can be done by other remedial measures before resorting to the trephine. Slight symptoms may perhaps be dependent upon concussion of the brain, or upon some slight pressure, either by blood or by bone; and such symptoms may pass off under the influence of judicious treatment. But if the symptoms are urgent,—if they indicate a decided pressure upon the brain, then operative interference becomes necessary.

And, from what has already been said, it follows that, with a wound leading down to the bone, we ought to operate at once. If the symptoms are slight, the operation may be successful; but if the symptoms are urgent,—if compression of the brain is decided and strongly marked,—there is every probability that all our efforts will be unavailing; for in such cases it very rarely happens that the brain-symptoms are dependent upon the depressed bone. The severe symptoms in fractures with depression arise, for the most part, from extensive extravasations of blood, or some serious lesion of the brain-substance itself; and hence the reason of an operation being so seldom of any use. Still, notwithstanding all this, it is our duty to operate, as the symptoms may, after all, be wholly dependent upon the bone. Cases are certainly now and then met with in which symptoms of a very urgent nature persist so long as the bone remains depressed, and are relieved only by its removal.

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* *Lect. on Surg.* vol. i. p. 173.

Of this, the most remarkable case is Cline's,* in which the symptoms continued for the extraordinary period of thirteen months, and still were relieved by the removal of the bone.

As a general rule, a depressed piece of bone may be allowed to remain in a child without producing the serious results so commonly noticed in an adult; and, consequently, we may in a child postpone the elevation or removal of the broken bone, which in an adult we should proceed to operate upon at once.

In operating for a fracture with depression, the only object is to elevate or to remove the fragments which are driven down. Now if this can be done by means of the elevator only, so much the better. Should this not be feasible, then we must see if we can gain sufficient room for the elevator by the removal of a slip of the sound bone overhanging the depressed fragment; and this is to be done by Hey's saw, if possible. The use of the trephine, as far as depressed bone is concerned, is to be restricted to those cases in which the edge of the fracture is regular, and without corners. And in trephining, great care should be taken to remove as little bone as possible; but, in our anxiety not to remove too much, we must be especially careful, and be sure that no irregular margin of the inner plate is left pressing upon the brain. In looking over the skulls in our different museums, it is curious and most instructive to observe how frequently a sharp edge of the inner plate of the bone has been left depressed.

After the removal of parts of the skull, it was the custom in former times to protect by plates of silver, or lead, or by some other means, the portion of brain thus left exposed. Of late years, however, this practice has been abandoned; and now, the protection of the brain is left to the thickened dura mater and integuments, for it rarely happens that ossification takes place sufficiently to fill up the gap. Patients, under such circumstances, may go on unharmed, for years. Occasionally, however, the cicatrix gives way, hernia cerebri follows, and the patient dies. Thus it happened to a young girl, in a violent fit of coughing, during which the cicatrix suddenly gave way.†

Finally, in a fracture of the vault, injury of a large venous sinus may occur; and in a compound fracture, such an injury may be followed by hæmorrhage of an alarming character. But, however alarming such bleeding may at first sight be, it is generally said that the danger is more apparent than real; the bleeding may be profuse, but it is easily controlled. Indeed, M. Chassaignac* states, that he had not been able to find on record a single instance of fatal hæmorrhage from a sinus thus wounded. There is, however, in the Museum of St. George's Hospital a preparation of a compound fracture of the skull laying open the left lateral sinus; and in this case, the patient, a powerfully-built man, aged 51, died of repeated attacks of hæmorrhage.

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* *Med.-Chir. Rev.* vol. i. p. 471.

† *Edin. Med. Essays*, vol. ii. p. 217.

An injury of one of these venous sinuses may also lead to fibrinous deposits within the sinus, and suppuration with all its secondary consequences. And pyæmia may, as a matter of course, follow any fracture of the vault; but pyæmia is much more frequently met with in the slighter injuries,—scalp-wounds, or contusion of the bone. Thus in twenty-three cases of simple scalp-wound or contusion of the bone, which ended fatally at St. George's Hospital within the space of ten years, purulent infection was noticed in fourteen instances; whereas in seventy-eight cases of fracture terminating fatally within the same period, it was noticed in six cases only; and even of these, five were compound fractures. The fact is, that in far the greater number of fractures the patient dies long before the period at which purulent infection usually sets in.

Fractures of the base. Fractures of the base of the skull are either direct or indirect; that is, the bones either give way at the spot which was actually struck, or at a point more or less remote from the seat of the injury.

In the vault, fractures are, as we have seen, for the most part direct; but in the base, direct fractures are, comparatively speaking, very rare.

At certain parts, however, the bones of the base of the skull are remarkably thin and brittle; so thin, that if direct pressure is brought to bear upon them they readily give way. Thus scissors, slate-pencils, tobacco-pipes, bayonets, have been thrust into the skull through the orbits, the nostrils, and the occipital bone; and the condyle of the lower jaw has even been driven into the middle fossa of the skull.

Thrust-wounds in these regions, and especially those of the orbits and of the nostrils, are of great importance, from the readiness with which the brain may thus be injured.

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* *Des Plaies de Tête,* 1842, p. 70.

Injuries of this kind occur most frequently about the orbits, and in no class of cases is the Surgeon more likely to be put off his guard as to the exact nature and extent of the injury. At first, all that may be apparent is the slight injury of the external parts—a trifling wound of the upper lid, and sometimes not even this, for the instrument may have slipped under the lid, and left merely a patch of ecchymosis on the conjunctiva. Brain-symptoms there may be none. Two or three days may pass over, during which the patient goes about as usual; then, brain-symptoms make their appearance, sometimes suddenly, and the patient dies in the course of a few hours, or days, and the true nature of the case is revealed only by the post-mortem examination. Such is the history of the cases recorded by Morgagni,* Sir A. Cooper,† Sir P. Crampton,‡ Guthrie,§ and J. Painter.‖ In other cases, recovery has taken place notwithstanding serious injury of the brain, indicated by severe brain-symptoms,¶ or by brain-protrusion.** One such case of recovery is constantly quoted, in which it has, however, been made clear that the brain could not have been injured. François de Lorraine, Duc de Guise, is represented†† as having recovered after a lance had passed immediately *above* the eyeball, and through a part of the skull. But on referring to the report of the celebrated Ambroise Paré,‡‡ who had charge of the case, it has of late been proved that the lance did not pass *au-dessus*, but *au-dessous de l'œil;* and, consequently, that the skull was not even injured.

What has just been said of direct fractures of the orbit applies equally to thrust-wounds through the nostrils. Whilst fencing with a walking-cane with one of his comrades, a soldier was hit on the nose; but the only appearance of injury was a small puncture, not larger than a leech-bite, on the left ala. The man died a few days afterwards, with brain-symptoms; but the exact nature of the case was never even suspected. At the post-mortem examination, however, the brass ferule of the walking-cane was found in the skull, close to the left side of the sella turcica, and this had led to extensive inflammation of the membranes of the brain.§§

A direct fracture of the base has also happened by the condyle of the lower jaw being forcibly driven against its fossa, the diaphanous plate of which it has broken through. Of this fracture there is a specimen in the Museum of St. George's Hospital. The bottom of the left glenoid fossa is broken, and the condyle of the jaw projects slightly into the cavity of the skull. But a still better-marked case is that quoted by M. Chassaignac,[*] in which the right condyle of the lower jaw was driven into the skull by a fall from a great height on to the chin. The man lived for between five and six months, during which he always complained more or less of his head, and ultimately died with brain-symptoms. The right condyle of the lower jaw was found pressing against the middle lobe of the brain, in which there was a large abscess.

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* Lett. 51, vol. iii. p. 121.

† *Lect. on Surg.*, Tyrrell, vol. i. p. 295.

‡ *Dublin Jour.* 1851, p. 352.

§ *Inj. of Head*, p. 137.

‖ *Dublin Jour.* 1851, p. 353.

¶ Morgagni, Lett. 51, vol. iii. p. 123.

** *Lancet*, 1837-38, vol. ii. p. 16.

†† Boyer, *Mal. Chir.* t. v. p. 83, 4e edit.

‡‡ *Œuvres de Paré*, édit. Malgaigne, Paris, 1840, t. ii. p. 25.

§§ *Dubl. Jour.* 1851, p. 347.

And now as to indirect fractures of the base of the skull. These fractures are very common; so much so, indeed, that they form by far the greater part of the fatal injuries of the head occurring in our civil hospitals. Such fractures were for the most part, and for a long time, looked upon as fractures by contre-coup. But modern researches have proved that fractures by contre-coup are very rare at the base of the skull; and a close analysis of fractures of the base shows that the bones of this region may be broken in different ways.

A blow upon the perpendicular portion of the frontal may give rise to a fracture of the orbitar plate of this bone, without any injury whatsoever being perceptible in the intervening osseous tissue. Of this an example happened at St. George's Hospital in the year 1849; and a very similar case is related by Boyer.[†]

The central bones of the base may be the only bones broken when the front and back part of the head have been caught between two opposing forces.

Fractures of the base may also be produced by the force acting from below upwards, the shock being transmitted through the intermedium of the spinal column; and, as in the previous instances, the bones broken may be far away from the spot which was struck. Alighting on the knees, or on the feet, in falls from great heights, gave rise, in one instance,[‡] to a breaking off of the apex of the right petrous bone, and of both posterior clinoid processes; in another instance,[§] to a fracture also of the right petrous bone, and a slight fracture of the same side of the sella turcica; and in a third instance,[‖] the only bone broken about the skull was the cribriform plate of the ethmoid; every other bone in this region was perfectly sound.

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[*] *Plaies de Tête*, p. 158; *Journ. Hebd.* t. iii. No. 37, Sept. 1834.

[†] *Journ. de Méd.*, août 1766, Paris.

[‡] *Journ. l'Expér.*, novembre 1843.

[§] *Bull. de la Soc. Anat. de Paris*, 1848, p. 193.

[‖] *Id.* 1848, p. 258.

But fractures such as these are, one and all, of rare occurrence, and but very few such cases are recorded by modern Surgeons.

Impulsion of the spinal column forcibly against the condyles of the occipital bone is supposed by some Surgeons to be the cause of the fractures so frequently observed at the base of the skull. Such was Earle's opinion,* and Sir B. Brodie states that his own experience corresponds very nearly with that of Earle; and lately, Mr. Hilton, in his valuable *Lectures on the Cranium* (p. 61), comes to the conclusion that the frequency of the fractures occurring through the petrous bone is dependent upon the forcible impulsion of the spine against the occipital bone.

That certain fractures of the base may be thus produced there is no doubt; but that most of the fractures of this region happen otherwise has, I think, been proved also beyond a doubt. A fracture of the base may be strictly limited to the front, middle, or back part of this region of the skull; and preparations illustrating these different fractures have for many years past been in the Museum of St. George's Hospital. But, as far as I know, Dr. Aran† was the first to prove, by experiments, how certain fractures came to be strictly limited to certain regions. In precipitating a large number of bodies from various heights on to the head, Dr. Aran found that the part of the vault which first struck the ground gave, as it were, the key to the fracture which would take place at the base. Similar results were also obtained when diffused blows were dealt upon different parts of the skull by means of a large and heavy hammer.

In the front part of the vault, injuries thus produced led to a fracture of the anterior fossa; in the middle part of the vault, they led to a fracture of the middle fossa; and at the back of the head, to a fracture of the posterior fossa. In no single instance was a fracture detected at the base, without a line of fracture in the corresponding part of the vault.

Taking, then, these experiments of Dr. Aran's, it will be found that the line of fracture, instead of beginning at the base, starts from that part of the vault which was first struck, and stretches from thence into the base. And the truth of this has been proved by an analysis which I made of all the cases of fractured base of the skull admitted into St. George's Hospital during a period of ten years, in the great majority of which the cause of the fracture was either a fall from a great height, or a blow from some heavy instrument.

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* Sir B. Brodie, *Med.-Chir. Trans.* xiv. p. 329.

† *Arch. gén. de Méd.* 4e sér. t. vi. p. 180.

But, to trace out these fractures accurately, the skull must be divided into three different zones or segments: an anterior zone, formed by the frontal, the upper part of the ethmoid, and the fronto-sphenoid; a middle zone, by the parietals, the squamous and the anterior surface of the petrous portions of the temporals, with the greater part of the basi-sphenoid; and a posterior zone, including the occipital, the mastoid, and the posterior surface of the petrous portions of the temporals, with a small part of the body of the sphenoid.

With the skull thus divided, the line of fracture, in the less severe cases, is strictly limited to one of these zones. Out of twenty-five cases, the line of fracture was found to be thus strictly limited: to the anterior zone in five cases; to the middle one in fourteen cases; and to the posterior one in six.

In severer cases, the line of fracture starting from the vault spreads into two of the fossæ at the same time; and this is readily accounted for by the position of the middle fossa, which, wedged in between, and firmly articulated with, the bones of the other fossæ, either receives or transmits the injury. Thus, out of twenty-nine cases in which the line of fracture occupied two of the fossæ at the same time, in fourteen it was the middle and anterior fossæ which were implicated; and in fifteen, the middle and posterior.

In the most severe cases, all three fossæ may be implicated at the same time; but, within the ten years, this happened only in ten cases.

Such an analysis points out, moreover, that the middle fossa, either alone or in combination with the other fossæ, is the region in which fractures most frequently occur. Out of the sixty-four cases, the middle fossa was broken in no less than in fifty-three cases.

In the severer forms of injury there may be, in various parts of the base, some small circumscribed fractures in addition to, and having no connexion with, the main line of fracture. Thus, the roof of the orbit is sometimes broken independently of, and away from, the principal fracture; and so, too, may the posterior clinoid processes be thus broken.

The only *symptoms* that can be depended upon as indicative of fractured base of the skull are connected either with an escape of some of the contents of the skull, or with an injury done to the nerves as they are emerging from the skull.

The contents of the skull which may escape in a fracture of the base are blood, watery fluid, or brain-substance. The watery fluid and the brain-substance must be left for further consideration, and so, too, must the injury of the nerves. Remains then the escape of blood.

And now, in order that this escape of blood may take place, the line of fracture must run in certain given directions; it must in its course involve some of the large vascular channels lying at the base, and it must, moreover, open a road through which the blood can get out of the skull into some part where its escape may be visible. But should it so happen that the injury does not produce effects such as these, there may be a very extensive fracture of the base, the existence of which cannot be revealed until the post-mortem examination takes place.

A fracture at the base may manifest itself by an escape of blood into the cellular tissue of the orbit and eyelids; by bleeding at the nose, or subsequent vomiting of blood; by bleeding from the ears; by an escape of blood into the cellular tissue in the mastoid region, or into that of the back of the head.

A fracture involving the orbitar plates of the frontal, and extending into the sphenoid, may lay open either the venous channels in this region or the ophthalmic artery,—the former much more commonly than the latter.

The blood, at first poured out at the back of the orbit, soon makes its way forward; readily infiltrating the loose cellular tissue of this region, it first shows itself under the ocular conjunctiva, and subsequently spreads into the eyelids. First the ocular conjunctiva, then the lids; such are the points at which blood coming from the bottom of the orbit must show itself. But it is the effusion of blood under the ocular conjunctiva which must guide us in our diagnosis, and for this purpose the effusion must not consist of a few patches only; it must extend into the cellular tissue of the orbit beyond our sight. As to the lids, the lower one generally becomes discoloured before the upper one. M. Velpeau thinks that the lower lid is always the first to be discoloured; but I have seen several cases of fractured base in which the ocular conjunctiva and the upper lid were ecchymosed without any discoloration of the lower lid.

Effusion of blood under the ocular conjunctiva is, then, the sign by which a fracture of the front part of the base may be recognised. But a fracture of this region may exist without any effusion of blood under the ocular conjunctiva, or the lids only may be discoloured; and in such cases it must be borne in mind that, however extensive the fracture, it cannot be diagnosed.

Out of twenty-three cases of fractured base, involving more or less extensively the orbitar plates of the frontal, all of which occurred at St. George's Hospital within the space of ten years, it was found, in eight cases, that there were no traces of extravasated blood to be seen either in the eyelids or under the ocular conjunctiva; and in five cases, that the effusion of blood occupied the eyelids only: so that in these thirteen cases there could have been no suspicion whatever as to the existence of a fracture. But, on the other hand, the nature of the injury was made manifest in the ten remaining cases by the blood effused under the ocular conjunctiva and in the lids.

Blood may, however, be effused into the lids and under the ocular conjunctiva, in fractures of the malar, or of the superior maxillary, bones; and this may give rise to an error in diagnosis. But such cases are of rare occurrence. One was published some few years back by Mr. Holmes.*

Effusion of arterial blood at the back of the orbit, in consequence of a fractured base, is of further interest, inasmuch as it may ultimately lead to a traumatic aneurism, which may go on increasing in size, and thus imperatively call for surgical interference.

Three such cases have occurred, within the last few years, to London Surgeons; two at the London Hospital itself, and one at the Seaman's Hospital. In all these three cases, the history and the symptoms left no doubt as to the nature of the injury; in all three, a ligature was ultimately applied to the common carotid, and in all three recovery followed this operation.†

Bleeding from the nose or mouth, or vomiting of blood, occurs, not unfrequently, after injuries of the head; but the great vascularity of the membrane lining these cavities renders this bleeding much less valuable as a diagnostic sign of fractures of the base than that which proceeds from the ear. Still, if the bleeding be copious, and especially if it continue for some time, there is no doubt that it then becomes a symptom of great value as a means of diagnosis. Out of thirty-two cases of fractured base, implicating the central bones of this region, all of which occurred at St. George's Hospital in the space of ten years, bleeding from the nose or mouth, or subsequent vomiting of blood, was present in no less than in fourteen instances. The symptoms in these cases were such as to lead to the belief that a fracture existed in some of the bones of the base corresponding to the pharynx or nose; and dissection proved that out of the fourteen cases, the fracture was confined in four cases to the ethmoid; in three, to the body of the sphenoid; and in one, to the basilar process. In five cases, the fracture involved both the ethmoid and the sphenoid; and in one case it extended not only through these bones, but through the basilar also.

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* *Association Medical Journal*, 1855, p. 967.

† *Med.-Chir. Trans.* vol. xxii. pp. 124-134; xxxvi. p. 221.

In the vomiting of blood, proceeding from a fractured base, it not unfrequently happens that the fluid thrown up is of a dark bistre colour; having been swallowed and retained in the stomach for some time, the blood has, in fact, been more or less acted upon by the gastric juice. Such appearances I have several times noticed when vomiting occurred after the subsidence of the symptoms of concussion which accompanied the fractured base.

Bleeding from the ears, in severe injuries of the head, has, for many years past, been held, and deservedly so too, as one of the most valuable diagnostic signs of fractured base. But this bleeding, to be of any value as a means of diagnosis, must be of a serious nature, and, above all, it must continue for some time. With such a bleeding, it may be safely diagnosed that there is a fracture of the base running through the petrous bone, and opening up a communication between the cavity of the tympanum and some of the numerous and large vascular channels which surround this bone, or with an extravasation of blood within the cranium itself.

Out of thirty-two carefully dissected cases of fracture of the middle fossa implicating the petrous bone, the flow of blood from the ear was profuse and continuous in fifteen cases, and in all these cases the diagnosis of the injury was clear.

On the other hand, fractures of the temporal bone frequently occur in which there is no sign that can lead to the supposition of such an injury. In such cases, either the line of fracture does not extend into the tympanum, or, if it does, the membrana tympani is not ruptured, and the blood cannot consequently get into the external meatus. Thus, in twelve of the seventeen remaining cases, the tympanum was not involved in the fracture, and in the other five cases the tympanum was fractured, but the membrana tympani was not ruptured.

In those cases in which a fracture of the petrous bone communicates with one of the venous sinuses on the inside of the skull, and in which there is no rupture of the membrana tympani, there can be no bleeding from the ear; but, in such cases, the blood poured into the cavity of the tympanum soon finds its way through the Eustachian tube, so that there may be bleeding from the nose or from the mouth, or subsequent vomiting of blood. Of this, careful dissections leave no doubt. And this passing of blood from the cavity of the tympanum through the Eustachian tube may even take place when there is a rupture of the membrana tympani; so that, in some few cases of fractured petrous bone, we may actually have bleeding both from the ear and from the nose at the same time.

Extravasation of blood, and consequent discoloration of the skin, appearing in the mastoid region some hours after a severe injury of the head, may lead to the suspicion of a fracture involving the posterior part of the base; and all the more valuable will this sign become, if the injury did not bear directly upon this region, and especially if it bore upon the opposite side of the head.

A discoloration of the integuments of the lateral parts of the neck, appearing subsequent to an injury of the head, may also serve as a guide to the diagnosis of a fracture of the base. The blood oozing from the fractured skull gradually infiltrates the cellular tissue of the neck, and thus ultimately reaches the skin, which becomes discoloured, as if bruised.

And a sudden puffiness in the occipital region, with discoloration of the skin, some hours after a severe injury of this part of the head, may also be of use in the diagnosis of a fractured base. The large venous sinuses connected with the occipital may, when this bone is broken, be torn across, and thus give rise to an extravasation of blood, which, gradually oozing through the line of fracture, may ultimately show itself in the superficial parts, and thus reveal the nature of the injury.

Fractures of the base of the skull, even when clearly recognised, lead but very seldom to operative interference. All our treatment must be directed, not against the broken bones, but against the accompanying cerebral lesions. In some rare instances we may, however, have to resort to an operation, even in the base of the skull. Thus in a comminuted fracture, with depression, I have seen a fragment removed which proved to be the greater part of the roof of the orbit. And the trephine has been applied, and successfully too, close to the foramen magnum.*

What occurs about the broken bones, when the patient survives a fractured base? Does union take place? And if so, by what medium are the broken bones united?

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* *Med.-Chir. Trans.* vol. ii. p. 105.

In some cases, even after a lengthened period,—months, and years,—no trace of union has been found. In other cases, the line of fracture has been found united partly by dense fibrous tissue, and partly by a thin layer of inlaid bone. And in other cases, again, bony union has been perfect, and throughout the whole line of fracture. In some cases of bony union, porous bone has been found heaped up along the sides of the line of fracture on the inner side of the skull; and when the fracture passes through one of the sinuses, this heaping up of bone may be such that the channel becomes blocked up.

Separation of the sutures. A question has arisen whether a separation of the sutures can possibly occur, without the bones being in some way or another broken. As might well be supposed from the nature of the articulations about the skull, a separation of a suture without a fracture is a very rare form of injury. I have observed it but once. It occurred in the back part of the squamo-parietal suture. The temporal having been slightly separated from the parietal, and driven upwards, these bones presented at first sight the appearance of a fracture with depression.

In every other case in which I have met with a separation of the sutures, it has always been in connexion with extensive fractures stretching into the base. Thus, in seventy-eight cases of fractured skull, there were fourteen cases in which there was extensive separation of the sutures, two or more of which were sometimes implicated at the same time.

As to the frequency with which the various sutures give way, an analysis of these fourteen cases proves that separation of the coronal suture occurred in seven cases; in the lambdoid, it occurred in six cases; in the sagittal, in four; in the petro-occipital, in one; in the temporo-parietal, in one; and in the spheno-parietal, in one. It sometimes happens, when several sutures have given way at one and the same time, that a whole bone becomes detached from the other bones. Thus, in one case where there was complete separation of the coronal suture, the frontal was at the same time extensively separated from its connexions with the other bones of the skull, and thus all but isolated.

This separation of the sutures is, as a matter of course, most likely to occur before the adult period of life, and when the bones have not yet been soldered together. It has, however, happened at an advanced age, as proved by a case of Morgagni's,* in which the patient was sixty years old.

Coexisting, as separation of the sutures for the most part does, with extensive fracture of the base, this injury must be classed among the most dangerous to which the skull is subject. It invariably indicates that great violence has been done to the bones. Oftentimes it is accompanied by laceration of the pericranium, and separation of the dura mater; sometimes even by extensive laceration of both these membranes, through which the brain-substance may be squeezed out of the skull, and found lying immediately under the integuments.

A most extensive separation of the sutures, with fracture of the bones, may, however, take place without any injury of the cerebral substance. Of this, I once dissected a most remarkable instance. The skull was extensively broken; the two parietal bones were widely separated from each other, and on a different level in the whole length of the sagittal suture; the left bone was in its natural position, but the right was driven down about two lines. The brain itself was not in the slightest degree injured.

Disjunction of the sutures, in its symptoms and treatment, cannot be separated from fractures of the skull.

WATERY DISCHARGES IN CONNEXION WITH SEVERE INJURIES OF THE HEAD.

As an accompaniment of severe injuries of the head, a thin watery fluid is now and then found issuing either from the ear, or from the nose, or from some part of the vault of the skull.

From the ear. The watery discharge from the ear is that most commonly met with. As early as the year 1727, Stalpartius van der Wiel† published a case in which large quantities of a thin, clear, watery fluid had escaped from the ear, for several days, after a severe injury of the head. This case, and another quoted by Stalpartius from Joël Langelottus, are the only cases usually referred to as having been observed by the older Surgeons; but O'Halloran,‡ some thirty years later, also published a case of the same nature, and in some respects even more characteristic; and the elder Dease§ appears likewise to have been well acquainted with the occurrence of this peculiar watery discharge from the ear. But, notwithstanding the striking nature of these facts, the subject was subsequently lost sight of until some twenty years back, when M. Laugier,[*] by some carefully-made dissections, first brought to light the coexistence of this watery discharge from the ear with a fracture of the petrous bone and a rupture of the membrana tympani; and then followed the question, even now so much debated, as to the possible source of this fluid.

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* Lett. 51, art. 28.

† *Observat. rarior. cent. prior.*, obs. xv.

‡ *Inj. of the Head*, p. 120.

§ *Colles' Lect.*, by M'Coy, vol. i. p. 155.

The various opinions which have been broached upon this point may, however, be reduced to two classes: one, in which the fluid is said to be nothing but the serum of the blood; the other, in which it is said to be the secretion from some membrane.

This fluid was at first thought to be nothing but the serum from a clot of extravasated blood lying over and in direct contact with the fracture. Such was M. Laugier's first opinion, published in the year 1839, to which he has latterly added the "exudation of serum from the lacerated vessels lying along the broken bone, and the neighbouring soft parts."[†] M. Chassaignac also thinks that the fluid is due to the serum of the blood, but that it oozes through a fraying of the thin outer wall of some one of the large venous sinuses connected with the petrous bone.[‡]

Neither of these opinions has, it must be confessed, been borne out by subsequent experience.

The fluid has, in turn, been ascribed to one of the several secreting membranes with which the petrous bone is so closely connected. It has been thought to be the liquor Cotunnii; then the fluid from the cavity of the arachnoid; then, again, the cerebro-spinal fluid.

That the discharge is due, in some cases at any rate, to the escape of the cerebro-spinal fluid, there is now no longer any doubt. First mooted by Auguste Bérard and M. Nélaton,[§] this opinion was subsequently taken up and thoroughly investigated by M. Robert.[||] Anatomy, dissection of morbid specimens, experiments on the dead subject, all led to the conclusion that the watery discharge from the ear, after a severe injury of the head, is due to the escape of the cerebro-spinal fluid. And M. Chatin,[¶] in analysing this watery discharge, found its composition to be the same as that of the cerebro-spinal fluid, both being especially marked by the very small quantity of albumen and the large quantity of chloride of sodium.

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[*] *Comp. Rend. de l'Acad. des Sc.* 1839, p. 240.

[†] *Arch. G. de Méd.* iv^{e} sér. t. viii. p. 413.

[‡] *Mém. de la Soc. de Chir. de Paris*, tom. i. p. 542.

[§] *Compend. de Chir. Prat.* t. ii. p. 591.

[||] *Mém. de la Soc. de Chir. de Paris*, t. i. p. 502.

[¶] Id. p. 568.

The escape of the cerebro-spinal fluid implies a fracture cutting across the meatus internus and communicating with the tympanum, a laceration of the tubular sheath of the cerebral membranes surrounding the seventh pair of nerves within this meatus, and a laceration of the membrana tympani. Of these various lesions, the only one about the proof of which there has been any difficulty is the laceration of the cerebral membranes within the meatus. There is, however, in the Museum of St. George's Hospital, a preparation which I dissected some years back, and which leaves no doubt upon this point.

But there are many cases in which dissection proves that the fracture has nothing to do with the meatus internus; whatever its course, either across or perpendicular to the axis of the petrous bone, the fracture passes through the internal and middle ear without touching the meatus. In such cases, it is clear that the watery discharge cannot be due to the escape of the cerebro-spinal fluid. It is then said, by many Surgeons,* to be the liquor Cotunnii proceeding from the membrane of the labyrinth; and difficult, indeed, would it be, in many cases, to prove that the watery discharge is not in part due to this fluid, where the fracture runs through both the internal ear and the tympanum, which are thus made to communicate with each other, their investing membranes being torn. In opposition to this view, we have, however, the quantity of the fluid, which oftentimes is so great that we can scarcely realise the idea of its being all furnished by a membrane of so limited an extent. And to this we may add those cases of profuse watery discharge from the ear, after a severe injury of the head, in which it has been proved that there was no fracture involving either the internal or the middle ear, and no communication whatsoever between these cavities. Such a case occurred at St. George's Hospital in the year 1854. The man, having fallen off a ladder about twenty feet high, was admitted with a discharge of bloody fluid from the left ear, and a scalp-wound, not exposing the bone, at the upper and back part of the head. He died on the seventh day after the accident, with diffuse cellular inflammation of the scalp, and symptoms of cerebral mischief. As to the fluid from the ear, on the morning following the accident it was of a roseate hue, and flowing so freely that in less than an hour a couple of ounces were caught in a gallipot placed under the ear. The discharge went on thus for two days, the pillow-case being so soaked that it became necessary to have towels placed under the head. On the third day, the fluid was much less in quantity, and on the sixth there was but little of it, and it was of a puriform appearance. The temporal bone was carefully, and at several different times, examined both by Mr. Henry Gray and by myself. There was no fracture, and no injury whatsoever of the bone itself; there was no kind of communication between the middle and the internal ear; the membrane lining the cavities of the internal ear was perfectly natural in every respect; the membrane lining the cavity of the tympanum and the mastoid cells was intensely vascular throughout, and covered with a muco-purulent secretion; the membrana tympani was extensively ruptured at its anterior and inferior part. The case has been recorded by Mr. Henry Gray in the *Transactions of the Pathological Society of London*, vol. vi. p. 22. In this case there was no fracture; the watery discharge could not, then, be due either to the escape of the cerebro-spinal fluid or to an increased secretion from the arachnoid, or to a filtration of the serous part of the blood. There was no communication between the middle and the internal ear; it could not, therefore, be due to the escape of the liquor Cotunnii. But there was a rupture of the membrana tympani, and the membrane lining the cavity of the tympanum was intensely vascular; and this, I think, proves that, in this case, at any rate, the fluid proceeded from the inflamed membrane of the middle ear.

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* *Dict. de Méd.* 2ᵉ édit. t. xxix. p. 570.

Another case of copious watery discharge from the ear, after an injury of the head and without any fracture of the temporal bone, has occurred at St. George's Hospital within the last few weeks. The man was admitted with bleeding from the ear, which was followed by a copious watery discharge. He died; and on dissecting the temporal bone most carefully, Mr. Holmes could find no fracture in any part of it, and no injury whatsoever either in the tympanic cavity or in any part of the internal ear. The discharge was connected with fracture of the lower jaw just below the condyle: the lower fragment had perforated the wall of the meatus auditorius.

I have mentioned these two cases particularly to prove that cases do, now and then, occur in which an injury of the head has been followed by a copious watery discharge from the ear, without any fracture or injury about the petrous bone, or any communication between the middle and the internal ear.

What value, then, are we to attach at the present time to the watery discharge from the ear as a diagnostic sign of a fracture of the base? Can it now be said that a profuse watery discharge from the ear, after an injury of the head, is pathognomonic of fracture of the petrous bone? It must be confessed that we cannot say this. On the other hand, however, there is no doubt that the symptom still remains as one of great diagnostic value under certain circumstances.

A close examination of these cases of watery discharge shows that this fluid makes its appearance under different circumstances. In some cases, no discharge of blood, or only a very small quantity, precedes that of the watery fluid; the discharge is, in fact, watery, and unmistakably so, immediately after the accident. In other cases, a copious flow of blood, going on for some hours, precedes the watery fluid. In other cases, again, the flow of blood is decided, but to no great amount, and for no long period; and then, sooner or later, comes the watery discharge. There are, then, as far as is known at present, three classes of cases of this watery discharge.

In the first class, where the fluid from the ear is plentiful, and of a decidedly watery character immediately after the accident, there need be no doubt as to the nature of the injury,—the watery discharge is due to the escape of the cerebro-spinal fluid, which, as already stated, can only take place through a fracture of the petrous bone implicating the internal auditory canal and its membranes.

In the second class of cases, characterised by a copious and prolonged bleeding from the ear, followed by a watery discharge, a fracture of the petrous bone may also be safely diagnosed; but it cannot be said that the fracture follows any particular course. In these cases it must, however, be clearly understood, that it is not to the watery discharge that we can trust for our diagnosis, but to the copious and prolonged bleeding.

Thus far there is no difficulty. Not so, however, in the third class of cases, in which there is at first a discharge of blood only, neither copious nor prolonged, which is followed by a watery discharge, varying as to the time of its appearance—varying as to its quantity. It may be present within a very few hours after the accident,—it may be profuse within a very few hours after its appearance. These are the cases in which experience has, of late, proved that the diagnosis ought to be doubtful. The discharge of blood is certainly not of a character to warrant a diagnosis of fracture of the petrous bone; and as to the watery discharge, it is now well known that such a discharge may occur within a few hours after the accident, that its quantity may even be profuse, and yet that there may be no fracture.

It has been stated by some Surgeons abroad, and especially by

M. Robert,* that this profuse watery discharge, after an injury of the head, belongs especially to childhood and youth; but the cases which have fallen under my own notice, it so happens, have been for the most part beyond thirty years of age.

A profuse watery discharge from the ear has always been held as one of the very worst features in an injury of the head. At one time, indeed, so bad was this feature thought to be, that it was said that no patient ever recovered who presented this symptom. Such, in former years, was the opinion of the elder Dease,† and such, even in later years, was at one time the opinion of M. Robert.‡ But Stalpartius' first case, in which, after an injury of the head, complete recovery took place, notwithstanding a most profuse discharge of a watery fluid, had evidently been forgotten for a time; and, of late years, several cases of recovery have been recorded.

In recording cases of recovery after this profuse watery discharge from the ear, we must, however, for the future bear in mind carefully to note the precise circumstances under which the discharge took place, and especially the precise characters of the fluid from its very first appearance. It must be particularly stated whether the fluid was watery from the beginning, or whether it was merely bloody; and then, whether the flow of blood was continuous for any length of time. And unless these points are carefully looked to, there will be some doubt as to recovery having taken place after a fractured base.

From the nose. A discharge of a watery fluid sometimes takes place from the nostrils, after a severe injury of the head; but such a discharge occurs much less frequently from the nose than from the ear.

Attention was first called to this subject by a case which was under the care of Blandin, at the Hôtel Dieu, in the year 1840.§ The actual source from whence this fluid came was not clearly made out in this case; but in M. Robert's case,‖ which occurred in 1845, a careful examination proved that the dura mater lying over a fracture of the sella turcica was torn to the extent of about an inch, and that the visceral arachnoid corresponding to the anterior lobes of the brain was also torn. Moreover, some water dropt on to the sella turcica soon made its way into the nostrils, and, more especially, into the right side.

What are the characters of this watery discharge from the nostrils? Whenever carefully examined, the characters of this fluid have been found to be precisely similar to those of the profuse watery discharge from the ear belonging to our first class of cases. The fluid, then, is marked by its limpidness, and by its containing a large quantity of chloride of sodium, and little or no albumen; in fact, it is of the same nature as the cerebro-spinal fluid. M. Chassaignac,* however, sees here, as he did in the ear, nothing but a filtration of the serous part of the blood contained in the numerous venous sinuses in close connexion with the body of the sphenoid, the fluid escaping from the sinuses through a fraying of their walls. But here again, the chemical analysis of the watery discharge differing so widely from that of the serum of the blood, makes it impossible to admit that such can be its source. Whence, then, does this fluid come? The anatomical disposition of the cerebral membranes in the central parts of the base of the skull is such that, doubtless, a fracture of this region might involve the membranes, lay open the great reservoirs of fluid contained in the corresponding sub-arachnoid space, and thus account for the enormous discharge of watery fluid observed in these cases; and which in M. Robert's case flowed in large quantities after death, upon the body being turned with its face downward. And in addition to the sub-arachnoid space, situated over the body of the sphenoid, there is also here, in the sella turcica, the pituitary gland, connected with the infundibulum, which is continuous with the third ventricle. So that at this spot the watery discharge from the nostrils might be due to the escape of the fluid contained in the ventricles, if the pituitary gland and infundibulum were lacerated or destroyed by the injury. And such, one may infer from the post-mortem appearances, was the nature of Blandin's case.

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* *Arch. Gén. de Méd.* iv^e sér. t. ix. p. 407.

† *Colles' Lect.* by M'Coy, vol. i. p. 155.

‡ *Arch. Gén. de Méd.* iv^e sér. t. ix. p. 409.

§ *Gazette des Hôpit.* 1840, p. 205.

‖ Loc. cit. p. 590.

But it would also appear that, every now and then, this watery discharge from the nostrils may be connected with a fracture of the petrous bone. As the blood in a fracture of the petrous bone sometimes escapes through the Eustachian tube, so may the cerebro-spinal fluid poured into the cavity of the tympanum through a fracture implicating the internal auditory canal escape thus. One such case has been published by Dr. Foucard,† and another by M. Malgaigne,‡ in which a most copious watery discharge took place both from the ear and from the nostril, at the same time.

In dealing with this watery discharge from the nostrils as a diagnostic sign of a fractured base, it must, however, be borne in mind, that not unfrequently a copious watery secretion, perfectly clear and limpid, is poured out by the pituitary membrane itself. Some persons, indeed, are subject to periodical attacks of this kind, during which a perfectly clear fluid is poured out from the nostrils, in very large quantities, and for several hours together; and this it is which makes it so difficult in some cases, evidently of fractured base, to give any opinion as to the source of the watery discharge which has existed.

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* Loc. cit. p. 553.

† *Journ. de Chir. de Malgaigne*, 1846, p. 315.

‡ Ibid. p. 283.

From the vault of the skull. A discharge of a clear, watery fluid, precisely similar in its character to the watery discharge from the ear and from the nose, may also take place from any part of the vault of the skull, provided the injury extend not only through the integuments and the bones, but also through the cerebral membranes; laying open, in fact, the space between the visceral arachnoid and the pia mater.

The watery discharge in these cases, as in some of the cases connected with the ear and with the nostrils, is due, then, to the escape of the cerebro-spinal fluid.

In his valuable paper on the subject of watery discharges from the head after injuries, M. Robert states, that the first case of watery discharge from the vault which fell under his notice occurred in the year 1847; and that, until he had seen this case, he had always thought that these watery discharges existed only in fractures of the base of the skull.*

Cases of a watery discharge from the vault in compound fractures had, however, been noticed by some of our predecessors years ago; but the facts, as in the case of a watery discharge from the ear, remained buried in oblivion until the attention of the profession was especially directed to them by the many discussions to which this subject has of late years given rise.

The earliest published case of this watery discharge from the vault is dated as far back as the year 1672. The child, about seven years old, was under the care of Delamotte; nothing untoward occurred, and in about a month's time the wound was perfectly healed. The fact of a watery fluid having been discharged through the wound is not mentioned in the history of this case; but, in his accompanying observations, Delamotte expressly states that he very much wished to apply the trepan in this case, and especially on account of a long kind of sinus leading from the wound on the forehead deep into the inside of the skull, from whence flowed a large amount of watery fluid, the quantity of which was much increased each time the boy was made to blow his nose.*

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* Loc. cit. p. 596.

In a case which was under the care of Hey of Leeds,† in 1809, a watery fluid issued from a compound fracture of the forehead so copiously as to wet the child's nightcap considerably. The discharge gradually abated, and ceased about the end of three weeks.

In Dr. O'Callaghan's case‡ there was also a copious flow of bloody serosity from a wound connected with a fracture of the frontal bone; and in Dr. Hofling's case§ a compound fracture of the frontal bone was followed by a clear, watery discharge, which soaked through all the dressings, and oozed copiously and uninterruptedly for the space of eight days. Dr. Hofling published this case as one of chronic hydrocephalus luckily cured by the kick of a cow; but in the details of the case there is certainly nothing to prove that the child was threatened with the hydrocephalic affection which is said to have been impending.

But two of the most curious cases of watery discharge from the vault occurred after trephining for epileptic fits, apparently connected with injuries of the head. In one of the cases, Professor Dudley states that the watery discharge went on for three days and nights, and was so copious as to make it necessary to change towels, pillows, bolsters, and sheets, two or three times a day; and it was computed that the entire amount of the fluid discharged could not have been less than two gallons; and notwithstanding all this, the patient recovered.‖

In M. Robert's case,¶ the draw-sheet was completely soaked through during the night; and, on the following morning, the lips of the wound were found to be slightly united, except at the posterior angle, where there was a small opening, through which was flowing a clear, watery fluid, perfectly limpid, and saltish to the taste. On the third day the watery discharge had ceased, the wound having united in its whole length; but shortly afterwards the wound gave way at its posterior angle, and the fluid immediately reappeared, and continued to flow for two days, when it finally ceased. The man ultimately got well.

In the seven cases above alluded to, there is every reason to believe that the fluid was the cerebro-spinal fluid from the sub-

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[*] Mauquest Delamotte, *Traité Comp. de Chirurg.* vol. i. obs. 145, p. 544.

[†] *Surg.* p. 21, case 5.

[‡] *Dub. Med. Press*, vol. xiii. p. 81.

[§] *Arch. Gén. de Méd.* Nov. 1837.

[‖] *Amer. Journ. Med. Sc.* 1828, vol. ii. p. 491.

[¶] Loc. cit. p. 596.

arachnoid space; but there is no doubt that the watery discharge from the vault may proceed from the lateral ventricle. This has been proved by dissection, in a case where, after extensive sloughing of the brain, the parts had become covered with granulations: every thing was apparently going on well, when a discharge of a watery fluid occurred from the wound; the fluid, perfectly clear and limpid, was traced to a minute opening buried in the midst of the granulations, from whence it came away in drops, and sometimes in a jet, at each pulsation of the brain. The man ultimately died; and at the examination of the head, the minute opening through which the watery discharge had taken place was found to lead directly into the left lateral ventricle, the fluid of which had thus escaped.* And it was from the ventricle, I think, that the fluid came in the case mentioned by Mr. Erichsen,† to whom I am indebted for the following additional notes. It was not till the nineteenth day after the accident that the fluid made its appearance: it came suddenly, and was discharged in such quantities that the pillow was completely saturated with it during the course of the night; after this the boy lived four days, during which large quantities of the same transparent fluid continued to flow from the wound; and, even on the day of his death, the fluid was still running profusely. Unfortunately, there are no notes as to any examination of the head in this case; but, with such a history, I think it more than probable that the fluid did not proceed from the sub-arachnoid space, but from the right lateral ventricle, the posterior horn of which, thinned by an accumulation of fluid, gave way, and thus allowed of the profuse watery discharge, which suddenly took place on the nineteenth day after the accident.

What influence is the escape of the cerebro-spinal fluid through a fracture of the skull likely to exercise on the ultimate issue of the case?

Looking to fractures of the base only, it might at first sight be supposed that the escape of the cerebro-spinal fluid would exercise a most dangerous influence on the progress of the case. It cannot in truth be said, however, that the danger in these cases is dependent upon the escape of the cerebro-spinal fluid. The danger lies not in the gradual loss of the fluid, but in the severe lesions, extravasations of blood, and injuries of the brain-substance, which so commonly accompany a fractured base.

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* *Bulletin de la Soc. Anat. de Paris*, année 1838, vol. xiii. p. 13.

† *Surgery*, 2d ed. p. 276.

But, in looking to the compound fractures of the vault of the skull, in which the brain is oftentimes not injured, there we shall find that large quantities of this cerebro-spinal fluid may be lost, and that apparently without influencing the case very materially.

Out of the nine cases of watery discharge from the vault to which I have alluded above, seven recovered; and the details of these seven cases which recovered clearly prove that the watery discharge, however copious, did not appear to have any material effect.

And hence the broad plan of treatment in each case of watery discharge connected with an injury of the head is to be based upon the general symptoms which may exist. These cases must therefore be treated as any other severe injury of the head; the various symptoms, whatever they may be, must, in fact, be dealt with as they present themselves.

Concussion of the Brain.

A man receives a blow on the head, by which he is only stunned for a longer or a shorter period. What is said to have happened? Concussion of the brain.

A man dies instantaneously, or lingers some time perfectly unconscious, after an injury of the head; there are no marks of external violence. Again, what is said to have happened? Concussion of the brain.

The head is opened, and what is found? In one case, no deviation from the healthy structure; in another, simply great congestion of the cerebral vessels; in another, numerous points of extravasated blood scattered throughout the brain-substance; in another, a bruised appearance in some parts of this organ. In all, the case, in common parlance, is said to have been one of concussion of the brain.

Such are the after-death appearances ascribed by different Surgeons to concussion of the brain.

The teaching of the different schools, then, is, that in simple concussion we may either find nothing in the brain to prove that this organ has sustained any injury, the brain-substance and its membranes appearing to be perfect in all their parts, or we may find certain lesions, plainly showing how much the cerebral substance has suffered.

But it behoves us carefully to examine and see how far we are justified nowadays in admitting that these various appearances do really belong to simple concussion of the brain.

And first, as to those cases of instantaneous death ascribed to concussion of the brain, in which no deviation from the healthy structure of the cranial contents is detected.

A century and a half ago was published* the first case in which it was clearly and distinctly stated that concussion of the brain may prove instantaneously fatal, without there being, on dissecting the brain, a single trace of injury in any part of the cerebral substance or of its coverings. And this is the celebrated case of Littre, to which reference is always made, even in the present day, to demonstrate that simple concussion of the brain may be followed by instantaneous death; and yet, strange to say, the details of this case afford literally no proof whatever that the man was actually killed by concussion of the brain.

The case stands thus: a malefactor, young and strong, who had been sentenced to be broken on the wheel, determined upon destroying himself. Head foremost, and with his hands behind his back, rushing a distance of fifteen feet across the prison-cell, he dashed his head against the wall, and dropped down dead. On removing the skull-cap, every thing was found in its natural condition, and, in fact, perfectly healthy, save that the brain did not nearly fill the cavity of the cranium, as it usually does, and that its substance, as well as that of the cerebellum and of the medulla oblongata, was, both to the touch and to the sight, closer and more compact than usual. And, by way of explaining the sudden death, M. Littre adds, "From the violence of the shock, the brain had shrunk considerably; and, possessing but little elasticity, it could not recover itself, in consequence of which the distribution of the nervous influence throughout the body failed in an instant."

Such is Littre's case, upon which so much reliance has been placed, as affording the strongest proof that simple concussion of the brain may lead to sudden death. But what is there in this case to prove that this malefactor did really die of concussion of the brain? Nothing but the head was examined; and here, even, very little care appears to have been taken to ascertain the exact condition of the brain-substance, and no allusion is made to the cerebro-spinal fluid. And, above all, what is to be said of Littre having, in such a case of sudden death, omitted to examine both the spine and the heart?

Does not the very history in Littre's case at once suggest the idea that this man did not die of concussion of the brain, but of a broken neck? And yet this part was never even thought of. What value should we, in the present day, attach to an examination thus carried on in our own dead-houses? Few of us would, I think, hesitate to say that such an examination proved nothing. And if this be the case, why should we accept from Littre that which we should refuse to accept, under similar circumstances, from any living Surgeon?

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* *Mém. de l'Acad. des Sciences*, 1705, p. 54.

With its few details and its capital omissions, Littre's case is, then, to me, I must confess, of no value. And such, too, are the conclusions arrived at by M. Fano, who has of late been making some extensive and well-planned researches on the subject of concussion of the brain.

The same may, strangely enough, be said of every other case which has been brought forward to prove the all-important doctrine that concussion without lesion of the brain-substance may lead to instantaneous death. In Sabatier's case,* in Boyn's case,† in both cases of Mounier,‡ no vestige of injury was found either about the brain or its membranes; and in one and all of these cases there was the same fatal omission,—neither the spine nor the heart was examined. And thus it is with O'Halloran of Limerick.

The perusal of such cases as these would really make it appear as if concussion of the brain had, at one time, been thought to be the only injury by which instantaneous death could be produced.

In all cases of sudden death from injury, there is no doubt that the parts to be examined are the upper portion of the spinal marrow and the heart. Neither is there any doubt that, if these parts are not examined, it cannot fairly be said, in such cases, that death was owing to simple concussion of the brain.

A man fell from a height of about forty feet, and died instantaneously. There was an extensive injury of the head; but this was not enough to account for instantaneous death. Further examination proved that there was also a dislocation of the atlas on to the occipital.

The following is a case even more illustrative. Death was not instantaneous; but death was, at first,—and this it is which makes the case so valuable,—thought to be dependent upon simple concussion of the brain. In the year 1843, a man was admitted into the Hôpital St. Antoine, having fallen from a great height on to the pavement. He was collapsed, and in a state of perfect insensibility. There was no paralysis, neither were there any spasms of the muscles. In this state he remained for some hours, and then died. The head was examined. Not a single trace of injury was detected in any of the cranial contents,—every thing was perfectly healthy. The case was set down, by all those who had seen it during life and were present at the examination, as a case of death from concussion of the brain. It fortunately happened, however, that Dr. Deville, in going round the wards, heard the result of the examination, and thought it advisable that the spine should be looked to. He proceeded at once to the dead-house, laid open the spinal canal, and there found a most extensive extravasation of blood, completely filling up this canal in its whole length, and extending upwards, even beyond the point where the spinal marrow had been cut across, when the brain was taken out.*

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* *Méd. Opérat.* t. ii. p. 400.

† *Thèses de Paris*, 1818, No. lv.

‡ *Thèses de Paris*, 1834, No. cxix., p. 19.

Had it not been for Dr. Deville, would not this case have been handed down to us, among the others, as one of death from simple concussion of the brain?

A boy fell from a great height, and was brought into St. George's Hospital with urgent symptoms of concussion, and various other severe injuries, of which he died in a few hours. The head was examined, and, save a little extravasated blood beneath the arachnoid on the surface of both hemispheres, with slight bruising of the brain in two places at its under surface, the brain and its membranes were perfectly healthy. And so, too, was the chest examined, and here was found a rupture of the muscular part of the septum of the ventricles of the heart right up to its serous covering, which alone prevented the blood from being poured into the pericardium. True it is that the pericardium in this case was not filled with blood; but a little more and it would have been so, and a complication, perhaps immediately fatal, superadded to the injury of the brain. And what makes this case still more interesting, as far as concerns our present subject, is, that there was not the slightest indication of any injury having occurred to the chest. No ribs were broken; and thus the rupture of the heart might easily have passed unnoticed, had it not been for the rule, now existing for several years at St. George's Hospital, of examining the various parts of the body in the post-mortem examinations.

Other cases of a similar nature have fallen under my own notice; cases in which death was caused by rupture of the heart from injury, and in which death might have been ascribed to concussion of the brain, had not the heart been examined. It must be borne in mind, too, that instantaneous death, apparently caused by concussion of the brain, may in reality have been the result of fatty degeneration of the heart. Some years back, a man, middle-aged, and of spare habit, whilst endeavouring to lift a heavy clothes-basket on to his head, dropped down dead in Hyde Park. With such a history, the heart was first examined: there was no valvular disease, and no rupture of the heart; but there was extensive fatty degeneration of this organ. And now, supposing that the effort which cost this man his life had been made in endeavouring to save himself in a fall from a height, or to ward off a heavy blow from his head; and supposing too that, under such circumstances, the head only had been examined, and its contents found to be healthy, would not this case have been set down as one of instantaneous death from simple concussion of the brain?

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* *Mém. de la Soc. de Chirurg. de Paris*, t. iii. p. 180.

As matters stand at present, then, it still remains to be demonstrated that concussion may prove fatal without leaving a trace of injury in the brain-substance.

This conclusion differs, I know, widely from the teaching of some of the greatest masters in surgery; but I can only say that there is not on record, as far as I have been able to ascertain, a single instance in which the evidence of instantaneous death from simple concussion of the brain will stand the test of any thing approaching to a rigid scrutiny.

But of late years several pathologists, whose names stand preeminent in connexion with cerebral affections, have taught that in fatal concussion appreciable lesions are to be found in the cerebral structures. True it is that these pathologists are not all exactly agreed as to the precise lesion: some — Chassaignac,* Nélaton,† Sanson‡—taking merely the millet-seed-sized extravasations of blood disseminated in the substance of the brain, either on its surface or deep in its structure; others—Dr. Bright,§ Blandin,‖—taking not only these specks of extravasation, but also the circumscribed patches of contusion. Still, these pathologists one and all agree in stating that some deviation from the healthy structure is to be found in concussion of the brain when it proves fatal. And M. Fano, one of the latest writers on this subject, comes to this conclusion: "that the symptoms generally attributed to concussion are due, not to the concussion itself, but to contusion of the brain, or to extravasation of blood."* And to this I may add, that in every case in which I have seen death occur shortly after, and in consequence of, an injury of the head, I have invariably found ample evidence of the damage done to the cranial contents. Setting aside the cases of large extravasations of blood upon the surface of the brain, the most speedy death has occurred in cases where specks of extravasated blood have been disseminated throughout the cerebral substance, or where blood has been extravasated into the structure of the pons Varolii.

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* *Des Plaies de Tête*, p. 104. † *Path. Chir.* t. ii. p. 575. ‡ Ibid.

§ *Med. Cases*, vol. ii. part i. 1831, p. 408.

‖ *Gaz. des Hôp.* 1842, No. du 2 juin.

Thus far, rapidly-fatal concussion only has been considered; but what appearances does the brain present when the injury has not been of so severe a nature, and where the patient has survived for some short time, or a few hours?

In such cases as these, where death has not taken place until a few hours after the accident, whether there be any actual lesion or not of the brain-substance, there is generally found intense congestion permeating the whole of the cerebral structures; so much so that, upon slicing the brain, innumerable blood-points may be seen every where thickly studding both the gray and the white substance. Such were the appearances in the case of Hœvelius, referred to by Morgagni.† This extensive congestion is also noticed by Dr. Bright,‡ and by M. Fano, in two of his experiments,§ where the animals, after being thoroughly stunned for some few minutes, were allowed to come to again, and were then killed by other means within a minute or two after recovery. But the most strongly-marked case of this intense congestion is reported by M. Denonvilliers,|| to whom the notes of the case were given by Dr. Bayard. And what makes this case still more interesting is, that many of the circumstances connected with it are strangely like those of the celebrated case of Littre. Arrested, and failing in his efforts to get away, the man dashed himself head-foremost against a wall, his hands being tied behind his back. He was picked up immediately afterwards perfectly insensible, and died three-quarters of an hour after the injury. As far as the brain itself is concerned, there was not even a speck of extravasation either on its surface or in its substance, the consistence of which was perfectly natural. But the intense congestion of the vessels of the brain gave rise to a manifest alteration in the colour of its structures, its cut surfaces

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* *Mém. de la Soc. de Chir. de Paris*, t. iii. p. 199.

† *Lett.* 51, art. 10. ‡ Loc. cit. § Loc. cit., exper. 5th and 8th.

|| *Compend. de Chir.* t. ii. p. 606.

being thickly studded with the minutest blood-points, from whence oozed specks of fluid blood upon gentle pressure. And in this case, too, minute as was the examination in many respects, strangely enough there is no mention made as to any examination of the other parts of the body.

And now, as to the still slighter cases of concussion, where the patient is only stunned for a short time, and then recovers his senses completely. It is usually supposed that here, too, there is only some disturbance in the circulation of the brain, which being but slight, soon passes off.

As may be readily supposed, it happens but very rarely that there is any opportunity of examining the state of the brain in these slight cases of concussion. Sometimes, however, in cases where very slight concussion has existed, death does occur, not from the injury done to the brain, but from some other severe lesion. And in two cases of this kind which I have had an opportunity of examining, and in which symptoms of concussion, of the slightest nature, had altogether passed off within a very short time, I was surprised to find that the brain-substance itself was actually injured. In one case, in which, after a blow on the head, there had been mere giddiness for a few minutes, and then complete recovery, some patches of contusion were found at the base of the brain; marked by minute specks of blood closely clustered together, these patches were, in two or three places, of the size of a shilling, and extended, about a line in depth, into the structure of the brain: there were no disseminated specks of extravasated blood. In the other case, after a fall on the back of the head, the symptoms of concussion soon passed off, and the patient died of some other disease eight days after the accident. In the cavity of the arachnoid, and adhering to its parietal layer, were found thin layers of extravasated blood. The large veins on the surface of the brain were congested; the brain-structure itself was much darker than usual from congestion; and in the centrum ovale, close to the right side of the corpus callosum, and extending partly into it, was an extravasation of blood of the size of a nut. This clot still retained the greater part of its colouring matter, but the cerebral structure around it was neither discoloured nor softened.

Well-marked traces of injury were found after death in the brain itself in both these cases. May not such lesions also exist in many so-called slight cases of concussion of the brain which recover? My own impression is, that such appearances exist more frequently than is generally supposed.

Many other morbid appearances have been given to concussion of the brain; but to these I should not allude, were it not that I find them mentioned in some recently-published text-books on surgery. For instance, among the after-death appearances in concussion of the brain, separation of the dura mater from the inner surface of the cranium, when the blow on the head was severe, is said to be a very common condition. As well might we say that in concussion of the brain the bones of the skull are often broken.

Concussion of the brain may be produced in different ways; either directly, from the force being applied to the skull itself; or indirectly, from the shock being transmitted through some other part of the body. What actually happens to the brain in concussion, M. Gama has ingeniously endeavoured to demonstrate, by means of a glass matrass filled with a solution of isinglass, approaching as nearly as possible to the consistence of the brain, in which he arranged several threads. And from what he observed in these experiments, M. Gama concludes that a blow bearing upon any part of the vault of the skull, in such a manner as to have its opposite point also in the vault, will lead to a separation of the brain from the skull at these two points. But if the blow bear directly upon the vertex, the separation of the brain will only take place at the point struck; and towards the base of the skull, all that will occur, on account of the flatness and extended surface of this part, will be a disseminated "contre-coup." Lastly, in a shock transmitted through the base of the skull, the motion being distributed from within outwards, there will be no separation of the brain at any point of the skull; thus pressed outwards, the cerebral mass, on the contrary, here becomes applied all the more forcibly against the osseous box.*

Such are M. Gama's conclusions. The experiment, it is true, is only a rough one; but notwithstanding this, some notion may, I think, be gathered from it, as to what takes place when the brain is shaken.

It is not many years since that Surgeons were at great pains to point out the different symptoms which, it was thought, served clearly to distinguish a case of concussion from one of compression. Has further experience proved the correctness of the distinctive characters about which there was at one time so much controversy? I think not. It must be admitted that there is no one symptom, or combination of symptoms, which will enable us to determine positively between concussion and the slighter cases of compression.

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* *Des Plaies de Tête*, 2^{e} édit. p. 101.

And this it is which renders an accurate diagnosis so very difficult, if not altogether impossible, in many cases of injury of the head; the difficulty itself being, no doubt, dependent in many cases upon the complex nature of the injury.

Cases of concussion of the brain are now commonly divided into three broad classes. All classifications of this nature must necessarily be vague and arbitrary; but, nevertheless, some classification of these cases will be found useful both as regards the symptoms and the treatment. In the slighter cases, the effects of the concussion are momentary,—loss of sensibility and of muscular power, interference with the circulation; these symptoms soon pass off. The patient comes to again, and proceeds about his business as if nothing had happened, retaining often no knowledge whatever of the accident. In the severest forms of concussion, the patient dropping instantaneously lies senseless and motionless; scarcely breathing, and with no pulse at the wrist. Little or no reaction takes place; and the patient expires within a few minutes, or lingers on for a few hours.

But cases of concussion holding the mean between these two extremes are to us, as practical Surgeons, of the greatest interest. At first, perfectly insensible, the patient lies motionless and all-but pulseless; with a countenance marked by extreme pallor, and a skin quite cold. The breathing, although feeble, is in the great majority of cases performed easily and naturally. The pupils vary very much—contracted, dilated; or one may be contracted, and the other dilated. The urine and the fæces are sometimes voided involuntarily. And in this state the patient may remain for a longer or a shorter period, after which he begins to rally.

No longer altogether insensible, he may be roused by loud calling; pinch the leg, and it will be withdrawn with an expression of peevishness about the countenance; the pulse becomes less frequent and more distinct; colour returns to the face, and the skin gradually regains some warmth. And among the earliest signs of amendment must be mentioned vomiting, which is to be looked upon as a good sign; and when it supervenes, sometimes appears to hasten the recovery.

And thus matters may go on for a few hours, or for a few days; but as soon as the patient is so far restored as to be able to make any complaint, headache, of a more or less severe character, is almost always found to be present. This pain in the head may exist for a longer or a shorter period, and then pass off; or it may soon be followed by other symptoms, indicative of intra-cranial inflammation.

Such are the symptoms attributed by most Surgeons to concussion of the brain, when it has been of a somewhat severe character. But at the bed-side of a patient labouring under such a train of symptoms, after an injury of the head, can we undertake to say that he is suffering from concussion of the brain only? Nay more, let the symptoms gradually pass off, and let the patient be so far restored as to be able within forty-eight hours to answer questions put to him; let him, in fact, give ample proof of returning intelligence; could we venture, in such a case, upon stating that the case was one of simple concussion? that the prolonged symptoms were not, in a great measure at any rate, due to an extravasation of blood within the membranes, to which the brain had become accustomed?

We may think that the case was one of pure concussion; and at the death of the patient, what do we find? Perhaps, an extensive extravasation of blood within the arachnoid.

An elderly woman having been knocked down and run over by a cab, was admitted into St. George's Hospital, with a severe injury of one of the hands and concussion of the brain; the symptoms of which, however, soon passed off, and she was up and about the ward in a few days. Ultimately, erysipelas made its appearance on the hand, and she died, after having been in the hospital about two months. From first to last the head-symptoms had been attributed solely to concussion of the brain; and yet, at the after-death examination, extensive layers of blood, membrane-like, were found in the cavity of the arachnoid on both sides.

A man aged fifty-three, having fallen down stairs, was admitted into St. George's Hospital, with what was thought to be simply severe concussion of the brain. From this he gradually recovered, and was in due course of time allowed to get up and go about the ward. He died, however, of an attack of erysipelas, two months after the accident. The brain-substance was perfectly healthy, but within the cavity of the arachnoid, on both sides, were the remains of an extensive extravasation of blood, membrane-like, and adhering to the parietal layer of the serous membrane.

I might mention several other cases in which extravasations of blood were found in the cavity of the arachnoid,—cases in which the symptoms of concussion had even been altogether transient, and in which death had been brought about by some other cause. Indeed, I cannot help thinking, from all I have seen, that many of the so-called cases of concussion, especially the severe cases in which recovery has taken place at a more or less remote period, have, in truth, been cases of extravasations of blood within the membranes.

There is also many a case recorded by eminent Surgeons, and as a matter of course quoted over and over again, in which partial paralysis and loss of memory are said to have taken place after, and to have been due to, concussion of the brain. But here, too, it is much more probable that effects such as these were due not to concussion only, but to some extravasation of blood, or to some local injury done to the brain-substance.

As we have some clearly-marked periods in the symptoms of concussion, so too must we adapt our treatment to these various periods.

In the first period, that of depression, the safest practice is certainly to do as little as possible—to avoid all interference either in the way of blood-letting, on the one hand, or in that of stimulating on the other. Bleeding to any extent, in such a state of depression, may be the cause of most serious mischief, even of death itself. And with regard to stimulants, recourse must be had to them as little as possible; for we cannot be sure that we may not be dealing with a case of extravasation of blood, or of bruised brain; and a period of depression, under such circumstances, would be the safeguard of the patient. Cases of concussion absolutely requiring stimulants are very rarely met with in practice; and even when of a very severe form, all that is necessary in the great majority of cases is, to apply warmth to the surface, and carefully to watch the case; but if it should so happen that the patient is manifestly in danger of sinking from depression of the circulation, then, no doubt, stimulants or cordials must be resorted to.

As is the state of depression, so too will be the state of reaction: slight depression will be followed by slight reaction; extreme depression by extreme reaction, which will be all the greater if stimulants are used.

And in the stage of reaction, so long as this reaction keeps within due bounds, here again it is better to abstain from all active interference; taking care, however, to exclude all possible sources of excitement; to keep the head and the shoulders well raised, and evaporating lotions constantly applied to the head, which in bad cases must be shaved. Precautionary measures such as these, with a mercurial and a saline purge occasionally, and great attention to diet, with perfect rest, will, in a large number of cases of concussion, carry the patient through this period.

When the concussion has been of a somewhat severe character, there is generally no difficulty in getting the patient to submit to the necessary regimen—his own feelings tell him, in fact, that it is absolutely necessary; but in the slighter cases, where all the symptoms soon pass off, feeling as well as he does for the time being, the patient not unfrequently resists all attempts at treatment, and then, within a few days, is laid low, with mischief of a very severe and dangerous nature—so dangerous, indeed, that notwithstanding all care, a few days more bring his life to a close.

In the cases of concussion which die, from some other cause, shortly after an injury, and in which no extravasation of blood or actual injury to the brain-substance is found, there is, it must be recollected, intense congestion of the cerebral vessels, which, in some cases, is so intense as to give a manifestly darker hue to the different substances of the brain. The cases revealing these early appearances are of the utmost value practically; they at once plainly point to the mischief which is likely to arise, and at once give the key to the treatment.

The great danger lies in the tendency which this congestion has of leading to inflammation, and hence the reason why the case is to be so narrowly watched; hence the reason why the state of the pulse, and all other symptoms, are to be so carefully inquired into, and even the slightest appearances of mischief, as far as possible, guarded against. But intra-cranial inflammation, taken as a whole, will form the subject of another section.

I cannot, however, dismiss this subject of concussion of the brain without again referring to a point which I consider of the utmost importance in all cases of injuries of the head, of whatever kind. In dealing with scalp-wounds and with fractures of the skull, I pointed out how necessary it was to take into consideration the state of the various viscera, and especially of the kidneys. To scalp-wounds and to fractures must now be added concussion of the brain; the diagnosis, the prognosis, and the treatment of which must be greatly influenced by the condition of the viscera.

Contusion of the Brain.

In dealing with the subject of concussion of the brain, allusion was incidentally made to the bruised appearances often observed about the cerebral substance, where the case had been set down as one of simple concussion.

It is this bruised appearance or contusion of the brain-substance which is now to be brought more directly under notice.

Bruising of the brain-substance presents itself under two different aspects; either spots of extravasated blood are clustered together in well-marked circumscribed patches, or these spots are disseminated throughout various parts of the cerebral mass at the same time. Hence a circumscribed and a diffused form of contusion of the brain.

The former, the circumscribed contusion, much the more common of the two, will be treated of first.

As in other organs, so in the brain, there may be different degrees of contusion. In the slighter cases, the bruised part, of a dark-purplish colour, is found upon close examination to be studded with minute specks of extravasated blood, not bigger than pin-points, thickly clustered together; the discoloration gradually lessening from the centre to the circumference, as the specks of blood become more and more scattered. The gray substance alone is affected. Under a gentle stream of water, the patch, if examined within a short time after the injury, retains both its discoloration and its consistence.

In the more severe cases, the central parts of the bruised portion, thoroughly infiltrated with blood, are of a uniform, dark-purplish colour, which extends some distance both into the gray and the white substances; imbedded in this part are little clots of blood of the size of peas, and around the circumference and in the deeper parts are specks of extravasation scattered more and more widely until they gradually disappear. The brain-substance—torn, broken up, and shreddy—readily gives way under a gentle stream of water, which, gradually loosening the clots of blood, carries them away, leaving little pits with irregular and shaggy margins, and thickly studded throughout with pin-point extravasations.

Such are the appearances at an early period after the injury. A few days later, and the bruised part, with its depressed shaggy surface, and sharp irregular borders, looks like an ulcer, and by some Surgeons has, in fact, been described as the traumatic ulcer of the brain. At this period, too, the brain-tissue to some distance around the bruise may be of a yellowish colour, and each little speck of extravasation may have its own circle of yellow surrounding it.

Slight contusion of the brain may sometimes be found alone; but, for the most part, the various degrees which have just been described coexist in the same brain.

As to the membranes of the brain, in the slighter cases of contusion, the meshes of the pia mater only are more or less filled with small clots of extravasated blood; in the severer cases, both the investing arachnoid and the pia mater are generally torn, and blood is more or less extensively extravasated in the cavity of the arachnoid, as well as in the meshes of the pia mater. Out of sixty-nine cases of more or less severe contusion of the brain, independent of compound fractures, I found blood extravasated into the cavity of the arachnoid in no less than in fifty-two cases. And in thirty-one out of these fifty-two cases, the extravasation was very extensive; so much so, indeed, in several instances, that the quantity is marked thus in the notes of the case: "within the arachnoid large quantities of blood spread out and capping the brain." In eleven cases, no blood was found in the cavity of the arachnoid; but in all these eleven cases, blood was found in the meshes of the pia mater, extending some distance beyond the actual seat of the brain-injury, and in six of them the extravasation was wide-spread. In the remaining six cases, no blood was found in the arachnoid, and none in the pia mater, except at the actual seat of the injury, and this only in very minute quantities.

Bruising of the brain may occur in every part of this organ; but all parts of the cerebral mass are not equally subject to this form of injury. Some parts of the brain are so frequently bruised that cases of this kind are seldom wanting in the dead-houses of our large hospitals; and other parts, again, are so very rarely injured that one or two cases only may be met with in a long series of years.

It is but very, very rarely, for instance, that an opportunity occurs of seeing the *medulla oblongata* or the *crura* thus bruised. There is, however, a preparation in the Museum of St. George's Hospital in which several small spots of extravasated blood may be seen scattered deep in the structure of the upper part of the medulla oblongata, as well as in that of the crura of the cerebrum and cerebellum. In this case, too, there were also spots of extravasated blood deep in the pons Varolii; some of these spots were of the size of pin-points, and others, again, as large as a small split-pea. No other part of the cerebral mass was bruised or lacerated; but there was an extensive extravasation of blood over the whole of the right hemisphere, and the cerebellum was bathed in blood. The bones of the skull were not in the least injured.

Of the *pons Varolii* only four other cases of contusion have been met with at St. George's Hospital within the space of sixteen years. And the cases of this kind on record are also but few in number.

In a case mentioned by M. Boinet,* the centre of the pons Varolii was bruised, and this was the only injury existing about the brain-substance. And in another case by M. Fano,† the structure of the pons Varolii was studded with several small extravasations of blood about the size of a split-pea; the anterior lobes of the brain were extensively bruised and torn, but the skull was not broken.

One point especially must be borne in mind in connexion with these traumatic extravasations both in the medulla and in the pons. The surface of these structures may be perfectly healthy, and yet well-marked spots of extravasation may exist deep in the substance, and that, too, even when there has been no bruising of any other part of the cerebral mass. Contusions such as these may then, it is evident, easily escape notice, unless very carefully sought after.

In the *cerebellum*, bruising and laceration occur more frequently than in the structures which have just been examined; and in this organ these injuries are, for the most part, to be found at its under surface. The spots of ecchymosis are generally small and superficially situated, and confined, moreover, to one lobe at a time. Sometimes, however, extravasations take place in the deeper parts, and then there may be either one largish single spot, as in a preparation in the Museum of St. George's Hospital, in which an extravasation of the size of a filbert is imbedded deep in the structure; or there may be, as in Blandin's case,‡ a large number of minute spots scattered in the substance of this organ. In the twelve cases of bruising and laceration of the cerebellum, notes of which I have by me, other parts of the brain were at the same time extensively bruised, and the skull was broken. The nature of the accident was not always very severe, and this must be borne in mind. In several instances I found that the cerebellum was thus injured by the patient having fallen in the street while drunk.

In the *cerebrum* itself it will be found that even here some parts of this organ are much more commonly affected than others. As in the cerebellum, so in the cerebrum, the under part is very much more frequently bruised than any other. Sometimes limited to a few patches of contusion, the injury much more commonly extends over the whole surface of a lobe, and oftentimes of two lobes at once. Both the gray and the white substance may be extensively involved; and, in depth, I have known the whole structure to be so broken up and destroyed that the lateral ventricle has been laid open. A man fell from a height of about eight feet, the result of which was extensive bruising and laceration of the under surface of both anterior lobes; freely laying open, on the right side, the lateral ventricle, into which the finger was readily passed. And, in another case, a man fell from a tree a distance of fourteen feet, and so injured the under surface of the anterior lobe on the right side that the lateral ventricle was here freely laid open.

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* *Arch. Gén. de Méd.* 1857, p. 50.

† *Rech. sur la Cont. du Cerv.* obs. xii. p. 25.

‡ *Gaz. des Hôpitaux*, juin 2, 1842.

But in the cerebrum, too, the deeper parts may every now and then be found bruised; and the bruise, thus deeply situated, may either exist alone, or it may coexist with an injury of the surface, although independent, and far away from it. And every part of the cerebrum may be thus injured; and being, perchance, very limited, the injury may here also easily escape notice. Thus, in one case, the septum lucidum was lacerated in nearly its whole length; it appeared to be bruised, and had several spots of ecchymosis in various parts of the remaining portion of the septum, and in the fornix at the back part. No other laceration was detected in any other part of the cerebral mass; but several patches of extravasated blood existed in the cavity of the arachnoid, and in the meshes of the pia mater. In another case, a minute extravasation of blood was found in the edge of the fornix, another on its under surface, and several specks also on the surface of the thalamus; the only other traces of injury were patches of blood in the sub-arachnoid tissue, corresponding to the posterior lobes of the cerebrum, and to the posterior part of the cerebellum. In a third case, the extravasation of blood in the brain was of the size of a nut in the right centrum ovale, close to the side of the corpus callosum; no other laceration could be detected in any other part of the cerebral mass, but several thin layers of blood were found extravasated in the cavity of the arachnoid. In a fourth case, the corpus callosum and the velum interpositum were slightly bruised, in connexion with superficial bruising of the surface of the brain; and in a fifth case, several minute specks of extravasated blood were discovered in the fornix and septum lucidum, in connexion with other and severe bruises of various parts of the brain. And in connexion with this subject it may be mentioned that a laceration of the floor of the lateral ventricle, even when very, very slight, may give rise to an extensive extravasation of blood into this cavity, should it so happen that the injury corresponds to the situation of one of the large veins in this region. In a preparation in the Museum of St. George's Hospital, there is a slight laceration of the septum lucidum, as well as of the floor of the left lateral ventricle, where a large vein was laid open, and the ventricle was full of blood.

Thus much as to circumscribed contusion of the brain. In the general or diffused contusion of this organ, the spots of extravasated blood, instead of being clustered together in one part, are disseminated throughout the brain, on the surface as well as in the deeper parts, or it may be in the deeper parts only.

Circumscribed contusion of the brain we already know to be of very frequent occurrence. Diffused contusion of this organ, we shall find, on the other hand, is but very rarely met with. Circumscribed contusion is for the most part easily detected, and at once clearly recognised. Diffused contusion is sometimes difficult of detection, and, without careful examination, may readily pass unnoticed.

Diffused contusion of the brain is characterised by specks of extravasated blood disseminated throughout the brain-substance. These minute extravasations vary from the size of the smallest pin-points to that of a split-pea. In the latter form, the extravasation could hardly escape detection; but in the former, the minute specks might, in slicing the brain, be easily mistaken for the cut surface of the cerebral vessels. A little care, however, will enable us to distinguish between the two. In the case of cut vessels, the specks can be easily wiped away, and then, by gently squeezing the brain, other specks of blood may be made to appear. The miliary extravasations cannot thus be wiped away; but, picked out with the point of a knife, they leave little holes, in which the concrete drop of blood was imbedded. The brain-substance around these minute holes may still retain its natural colour; or, some days after the accident, it may be of a yellowish colour, such as is so frequently noticed under similar circumstances in bruises of other parts. Thus, in Blandin's case, already alluded to, which terminated fatally some eight or ten days after the injury, each little spot of extravasated blood was found encircled by cerebral substance of a yellowish tinge, varying from a violet colour to a greenish yellow.

The specks of extravasated blood characterising diffused contusion of the brain may, in any case, be numerous, or they may be few; sometimes so few, indeed, that one speck here and there is all that can be found. And this points out at once what extreme care must sometimes be required in examining cases of this kind; and it also points out how readily a lesion of this delicate nature may escape notice in a rough examination,—such, for instance, as used formerly to be carried on in our dead-houses.

One of the best-marked cases of diffused contusion is that described by M. Chassaignac in the *Mém. de la Soc. de Chir. de Paris*, vol. iii. p. 208. Another equally well-marked case is that of Blandin above alluded to. In both these cases, the miliary extravasations were very numerous and widely scattered; but, in a case which occurred at St. George's Hospital in the year 1854, the spots, although well marked, were very few. In this case, three very small spots of extravasated blood were found in the substance of the anterior lobe of the left hemisphere; another small spot in the fornix, and another in the right lobe of the cerebellum. And these were all: some minute extravasations existed also in the cavity of the arachnoid, and in the meshes of the pia mater; but there was no fracture of the skull.

These minute traumatic extravasations of blood scattered throughout the brain-substance have of late years been looked upon, as I have already said, by some Surgeons of eminence, as especially belonging to concussion of the brain; but such appearances cannot properly be assigned to concussion. Miliary extravasations of blood, whether clustered together in one patch, or disseminated in various parts, belong, one and all, to contusion of the brain. The morbid appearances, although apparently so dissimilar, are essentially of the same character. The contusion, limited in one instance, is general in the other.

Bruising of the brain-substance may take place at the spot where the skull was struck; or the bruise may be in a part of the brain far away from the original seat of the injury. The one, then, is a direct contusion, the other a contusion by contre-coup, of the brain-substance.

And as an illustration of what takes place in contusion of the brain, reference may be made to experiments such as M. Gama's, in which may be seen the effects produced upon the spot where the blow bears directly, as well as the effects which occur in the parts diametrically opposite.*

Contusion of the brain is, however, rarely limited to the region where the blow was struck, except in cases where the bone has been driven down. In fissure of the skull it happens much more frequently that the bruised part of the brain is far away, and directly opposite to the seat of the blow. In severe injuries, both kinds of contusion, direct and by contre-coup, are sometimes found in the same brain.

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* *Des Plaies de Tête*, 2^{e} édit. p. 101.

Bruising of the brain occurs, then, in some parts of this organ much more frequently than it does in others. The upper part of the brain is seldom bruised. Out of thirty-six cases of bruised brain accompanying fractures extending from various parts of the vault into the base of the skull, the upper surface of the hemispheres was bruised in five cases only. The base of the brain is the part most frequently injured; but even here the various regions differ widely in this respect. The posterior lobes are rarely injured, the anterior ones very frequently, and the middle lobes the most frequently of all. Out of the thirty-six cases just alluded to, the posterior lobes were bruised in four instances only, the anterior lobes in eighteen, and the middle lobes in no less than twenty-five. In twelve of these cases, the anterior and the middle lobes were bruised at one and the same time, the injury having been most severe.

And now, bearing in mind what was stated as to the frequency of the fractures of the various regions of the base of the skull, the middle part of the base of the brain, like the middle fossa of the skull, will be found to be the most frequently injured.

The analysis given by M. Fano as to the frequency of the contusion of the various parts of the brain differs from that which I have just mentioned. M. Fano* found the anterior lobes more frequently bruised than any other part of the brain; but then the number of cases thus analysed was very small—only eight. Had M. Fano's numbers been larger, the results would, I think, have been pretty much the same in both analyses.

Why is it that the middle and the anterior lobes are so much more frequently bruised than the posterior ones? A glance at the anatomical relations of these various parts of the base of the brain affords, to a certain extent, a satisfactory explanation. The posterior lobes lie upon a soft cushion, the tentorium cerebelli; but the anterior and middle lobes are in contact with irregular and angular projections of bone, which, although rounded off to a certain extent, and smoothed down by the dura mater, are still both sharp and numerous.

This subject has been made one of importance by M. Fano,† who, after carefully pointing out the various pieces of sharp bone in these parts, expresses great surprise that no allusion should ever have been made to them in connexion with contusion of the brain by contre-coup. The following, however, are Sir Benjamin Brodie's own words, written some thirty years ago now: "The great irregularities which exist on the inner surface of the basis of the cranium sufficiently explain wherefore the inferior is more liable to be ruptured than the superior surface of the brain."* And nothing could be more explicit.

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* *Thèse sur la Cont. du Cerv.* p. 44.

† Loc. cit. p. 44.

Are there any means of recognising the cases in which the brain has been thus bruised and lacerated?

Dupuytren,† to whom we owe much of what is known of contusion of the brain, was decidedly of opinion that we had no means of recognising this injury. This celebrated Surgeon distinctly taught that contusion of the brain does not reveal itself by any symptoms until a few days after the accident; that is, until the period—four or five days after the injury—at which inflammatory symptoms begin to show themselves.

And such, too, was the opinion first entertained by Sanson. "It is not until after four or five days that the signs of contusion become manifest; and then these signs are similar to those of inflammation of the brain."‡ But in after-years, laying aside this opinion altogether, Sanson professed that contusion of the brain has its own characteristic signs, which, appearing at the very time of the accident, clearly reveal the nature of the injury.§ And the symptoms by which Sanson thought that he could thus at once recognise contusion of the brain are, in the severer cases, tonic spasms of the limbs; intense restlessness, with constant rolling and tossing about in bed; unconsciousness, more or less complete; drowsiness, without any stertorous breathing. And in the slighter cases, simply contraction of one pupil, or of one eyelid; spasmodic movements about some one muscle or another of the face or lips, giving rise to a difficulty of pronunciation.

Such was Sanson's teaching in his latter years; and such, for the most part, is the teaching of the present school of French surgery, wherein it is broadly and distinctly laid down that, as a general rule, contusion of the brain does at the very outset give rise to a train of symptoms by which the injury may be recognised, if the various symptoms be only weighed with due care.

But after careful and patient watching of many a case of severe injury of the head, I must confess that I do not think we are really in a position thus clearly to recognise a case of contused brain.

There is no doubt that cases of contusion of the brain are frequently met with, in which tonic spasms of the muscles and extreme restlessness, with constant tossing and rolling about, are the principal symptoms; but there is no doubt also, that as frequently, if not more frequently, cases of severe contusion of the brain are met with, in which the symptoms either never make their appearance until some days after the accident, or are altogether wanting.

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* *Med.-Chir. Trans.* xiv. p. 334.

† *Clin. Chir.* t. ii. p. 490.

‡ *Dict. de Méd. et de Chir. Prat.* t. viii. p. 452.

§ *Boinet, Arch. Gén. de Méd.* mai 1837, p. 39.

I have, I think, fairly tested Sanson's doctrine, both in the wards and in the dead-house; and, from all I have seen, I have been led to conclude, that contusion of the brain does not give rise to any symptoms immediately after the injury—that it has, in fact, no characteristic signs of its own.

M. Fano, to whose valuable thesis I have already referred, has come to the same conclusion. And in this thesis* will be found an able analysis of the memoir which M. Boinet† wrote for the express purpose of maintaining and proving the correctness of Sanson's views. In summing up the cases brought forward in this memoir, M. Fano proves that seven only out of the nineteen were really of any value for M. Boinet's purpose. In these seven cases, the so-called characteristic symptoms coexisted with contusion of the brain; but then, in these seven cases, there were also, about the head, other lesions of a serious nature, which may perhaps have had just as much to do with the symptoms as the contusion of the brain.

Why should not a thin stratum of blood widely spread over the brain—why should not laceration of the investing membranes of the brain, have something to do with the tonic spasm and the restlessness? In severe bruising of the brain, these lesions are very common; so common, that, as I have already mentioned, out of sixty-nine cases of this kind, blood was found extravasated in no less than in sixty-three. And, as a possible cause of the symptoms, there is also the intense congestion which, it is known, takes place in the brain-substance almost immediately after it has been bruised.

But why is it that such symptôms exist in some injuries of this kind, and not in others? To this the only answer that can be given is, that this is one of those questions which cannot be fairly met in the present state of our knowledge.

There are, then, no characteristic signs by which contusion of the brain can be clearly recognised; but, nevertheless, it may be predicted that the brain has been bruised, whenever the symptoms are severe after an injury of the head. At least, certain it is, that in severe injuries of this kind, and especially after diffused blows—the most common form of accident in civil hospitals—certain it is that in the vast majority of these cases the brain will be found bruised. Nay, more; if we bear in mind which parts of the brain are the most frequently thus injured, we may even go so far as to say that it is the under surface of the middle or anterior lobes which is bruised.

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* Op. cit. p. 23.

† Loc. cit.

Contusion of the brain must be considered as a most dangerous injury; but is it always fatal?

One sees patients recover after an injury of the head, in whom it was more than probable, from the nature of the accident and the severity of the symptoms, that the brain was bruised; but of this, unless in very rare circumstances, no positive evidence can be obtained.

When recovery does take place, the contusion is repaired in the same manner as apoplectic hæmorrhage into the brain. In the slighter cases, all traces of the contusion may have passed away, if death occurs independently of, and some time after, the accident; or the only trace left may be a hardened cicatrix, with, perhaps, some colouring matter in the centre. But clearer evidences of a former contusion of the brain are occasionally met with; and here, the appearances, as might have been expected, are precisely similar to those observed in old apoplectic effusions. If on the surface of the brain, the portion which had been bruised may present some of the well-known appearances so accurately described by Rokitansky,* in his peripheral form of apoplexy. Of this Mr. Henry Lee's case affords a well-marked illustration.†

In dealing with concussion of the brain, I have already remarked that it is more than probable that some of the cases so often quoted as instances of slight paralysis, or of loss of memory after concussion, were in reality cases in which the brain had been bruised. Of this I think that there can be no longer any doubt.

That which is most to be feared, when the brain has been bruised, is inflammation of the surrounding substance; and this it is which must be guarded against as much as possible. The great tendency in injuries of this kind is, that the brain and its membranes should become inflamed; and as this inflammation is apt to creep on most insidiously, every injury of the head in which the symptoms have been marked ought to be most carefully watched, and treated accordingly. Our watching ought to be carried on for days, for oftentimes the symptoms of traumatic inflammation suddenly show themselves, and without any manifest cause, when all was apparently going on well. The fourth or fifth day was stated by Dupuytren and by Sanson to be the period at which the febrile symptoms were likely to make their appearance. This, then, is the period when we ought to be most watchful for even the slightest sign of inflammation of the brain and its membranes; but of this I intend to treat at length in another section.

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* *Path. Anat.* vol. iii. p. 394.

† Guthrie, *Inj. of the Head*, p. 68.

PROTRUSION OF THE BRAIN-SUBSTANCE.

Protrusion of the brain may be the immediate consequence of, or it may come on some time after, the accident.

Contused and lacerated portions of brain-substance may be driven through a fracture of any part of the skull; such protrusions almost always, however, occur in some part of the vault, in connexion with a compound fracture and laceration of the cerebral membranes. And however dangerous such an injury may be, the records of surgery contain a large number of cases in which, after the escape of more or less cerebral matter, the patient has recovered, and that without any apparent detriment, either physical or intellectual. Opinions, however, differ as to the chances of recovery in wounds of the brain in different regions of the vault of the skull. On the one hand, Sir Benjamin Brodie* states that he had not been able to discover, among all the works which he had consulted, a single instance of recovery from a wound of the posterior lobes of the cerebrum; and in the great majority of cases in which a cure had taken place, the injury was confined to the frontal bone, and that part of the brain which is covered and defended by it. On the other hand, Mr. Guthrie's† experience led him to believe that an injury of apparently equal extent is more dangerous on the forehead than on the side or middle of the head, and much less so on the back than on the side.

But it occasionally, although very rarely, happens that brain-substance is forced through a fracture of the base of the skull, in direct communication with the ear or with the nose, or it might be with the pharynx. In such cases, the injury done to the brain-case and its contents must, as a matter of course, be most severe, and, with very rare exceptions, necessarily almost always fatal.

Of brain-matter forced through the meatus externus, I saw a case at St. George's Hospital in October 1856. The accident was caused by a fall head-foremost from a great height; and with profuse bleeding from the left ear were mixed minute portions of brain-substance, and two or three larger pieces, as big as peas, of the white substance of the brain were lying in the meatus externus. Two cases of the same kind are on record; one in the *Journ. de Méd. et de Chir.*, 1779, vol. lii. p. 454; and the other in the *Annales de Chir.*, 1843, vol. viii. p. 229.

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* *Med.-Chir. Trans.* xiv. 421.

† *Injuries of the Head*, p. 2.

Of brain-matter forced through the nostrils, a case is recorded in the *Compend. de Chir.* vol. ii. p. 595; and another in the *Bull. de la Soc. Anat. de Paris*, 1837, p. 228.

Injuries such as these are, I said, necessarily almost always fatal. Occasionally, however, recovery does take place. One such case I recollect seeing at St. Bartholomew's Hospital, under the care of Mr. Stanley. There had been a fall from a height of twenty feet; and, with some clots of blood, a portion of the brain, of the size of a hazel-nut, escaped through the right nostril. The injury was followed by severe inflammatory symptoms; but notwithstanding all this, the man, aged forty, was discharged from the hospital, cured, eighteen weeks afterwards. The case is published in the *Medical Gazette.*[*] And another case of recovery after an equally severe injury has lately been recorded in the *Amer. Journ. of Med. Sc.*, April 1859, p. 354. In this case, the patient, aged thirty, plumped from a great height on to the crown of his head; there was copious bleeding from the right ear, and with it a small quantity of brain-matter. On the following day, a fluid of a watery character was flowing from the ear; and in the meatus were several particles which, carefully examined, proved to be true brain-matter. The man returned to his duty five weeks after the accident.

I have never seen a portion of the brain forced into the pharynx, but I have found the contents of the pharynx within the skull, into which they had passed through a widely-separated fracture at the base.

Thus far those cases only have been considered in which protrusion of the brain occurs at the time of the accident. In all these cases it is the broken-up brain-matter which is driven out of the skull; about this there is no doubt.

But protrusions at times occur a longer or a shorter period after the accident, which have been described, more especially by English Surgeons, under the term of hernia cerebri; and under this general head have been included protrusions of divers natures, and some even having nothing of brain-matter in them.

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[*] New ser. vol. iii. 1846, p. 77.

Some protrusions are said to have arisen simply from blood extravasated on the outer surface of the dura mater. Described as *tumeurs hématiques* by M. Velpeau, such protrusions have nothing to do with the brain-substance; the dura mater is not even broken through. An outgrowth of this nature might present all the appearances of one form, at any rate, of hernia cerebri; and most difficult would it be, during life, to decide as to the precise connexions of the tumour. But cases such as these must be very rare.

In hernia cerebri,—such, I mean, as it is described by English Surgeons,—the protruded substance appears to have varied somewhat in its nature; but, whatever may have been the actual appearance of the tumour itself, the dura mater was at any rate torn through, and the protruded substance was more or less intimately connected with the brain. In some cases, the protrusion is described as having been chiefly composed of blood extravasated under the pia mater, between it and the surface of the brain, or in its most superficial parts. In other cases, the appearance of the protruded mass was that of true brain-substance, looking exactly like the structure of the brain, with which it was continuous. And in other cases, again, the tumour is represented as an over-abundant granulation from the brain, the injury of which it was destined to repair. Indeed, some Surgeons believe that this is the only form in which hernia cerebri shows itself: not then a protrusion of brain-matter; not a hernia cerebri; but simply a growth from its over-luxuriant granulation.

Personally, I have had but very few opportunities of examining the substance driven out of the skull in hernia cerebri, as but two cases of this affection have occurred in the wards of St. George's Hospital during several years past.

In both cases, the protruded substance certainly presented all the outward appearances of brain-matter; and in the last one, which occurred in the year 1855, bits taken away from different parts of the surface of the protrusion were, at various periods, examined microscopically: blood-cells, exudation-corpuscles, and many nerve-tubules were detected in every portion thus submitted to the glass; and this, at any rate, leaves no doubt as to the protrusion being, in some cases of hernia cerebri, formed, in part, of true brain-matter. I may add that, in this case, the first escape of brain-matter took place through a rent in the dura mater, immediately after the removal of a depressed piece of bone. No further escape of brain-matter occurred until after the fourth day, when the protrusion began to show itself; from this period it went on gradually increasing, and ultimately formed a large foul mass, portions of which sloughed off daily. Within a few days of the patient's death, however, the protrusion became much less, and the wound put on a healthier aspect. The immediate cause of death was purulent infection.

The destruction of brain-matter in some cases of hernia cerebri is sometimes very great. In a case published by M. Bouchacourt,* the destruction was so great that the lateral ventricle was laid open, and, for days, limpid fluid issued through the wound.

Is it true that the size of the hole in the bone has much influence in causing hernia cerebri? It has been generally taught, and Mr. Guthrie has stated, that protrusion of the brain "rarely or never takes place, when a considerable portion of the skull has been lost or removed; the brain being able to expand to such an extent as the inflammatory impulse from within may render necessary."†

But facts prove that hernia cerebri may, and does, take place even when large portions of bone have been lost. In the case of M. Bouchacourt,‡ the hernia cerebri showed itself after a piece of the frontal bone of the size of the palm of the hand had come away. I have also seen a hernia cerebri occur after a considerable loss of the frontal bone—the lower part of the perpendicular portion on the right side, and the whole of the corresponding orbitar plate. And a case occurred not long ago, at the Lock Hospital, in which hernia cerebri took place after separation of nearly the whole of the frontal bone.

There is no doubt that hernia cerebri is mainly due to inflammation of the brain, and to the effusion of serum and pus, which so commonly attend these cases. Where the brain protrudes, the cerebral substance around is for the most part congested, swollen, œdematous, and soft; yellow softening may extend more or less into the surrounding parts, and a great portion of the tissue may be broken down. Abscesses of various sizes, sometimes very large, are not unfrequently found in the hemisphere involved, and large effusions of various kinds fill the ventricles. And, in addition to all this, there is generally extensive effusion of lymph and pus, both in the cavity of the arachnoid and in the sub-arachnoid tissues.

Hernia cerebri may present itself in any part of the skull. It occurs, however, by far more frequently about the vault of the skull, and especially the frontal and parietal regions; but these localities are, it must be remembered, precisely those in which injuries with loss of bone occur also most frequently. Hernia cerebri is rarely found in fractures of the base, and for this reason, that in the great majority of instances the injury to the bone is here a simple fissure, and without any laceration of the dura mater. Whenever a fracture of the base is accompanied by a large-enough separation between the fragments, or by loss of bony substance, as well as by a laceration of the dura mater, then there is no doubt that hernia cerebri may arise. Such fractures are, however, very rare.

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* *Bull. de la Soc. Anat. de Paris*, t. xiii. p. 13.

† *Inj. of the Head*, p. 138.

‡ Loc. cit.

One of the most striking cases of hernia cerebri at the base of the skull was under the care of Mr. Cæsar Hawkins, a few years ago, at St. George's Hospital. The patient, a boy, aged 11, accidentally shot himself with a horse-pistol loaded with a bullet, which smashed the right malar bone below the orbit, and then lodged in the head. After he had recovered from the first effects of the accident, he went on without any marked cerebral symptoms for seven days, when he became restless, and then delirious; in the afternoon, brain-matter and blood began to be discharged, and a soft fungus-like growth showed itself in the wound, and the patient died, insensible, about thirty hours afterwards. At the post-mortem examination, considerable quantities of brain-matter were found protruding through the large gap made by the bullet in the sphenoid and temporal bones. The substance of the brain around the protrusion was vascular, and of the yellow colour usually found in such cases. The hernia cerebri in the middle fossa of the base of the skull is now in the Museum of St. George's Hospital.

Under fit circumstances, the protrusion may occur at an earlier or a later period—it may be days, it may be weeks. After the removal of the bone every thing may appear to be going on well for a long period, as long, in fact, as the dura mater remains entire; but, should any thing lead to the giving way of this membrane, and should this be accompanied by inflammation of the parts beneath, protrusion may, at any time, as already mentioned, be the consequence. There are cases on record in which the protrusion did not come on until after the second month, and some are mentioned in which the interval was even longer. The usual period, however, for such protrusions is generally at the time when inflammatory symptoms are most apt to set in,—that is, within a few days after the injury. Mr. Guthrie* states that those protrusions which are principally composed of coagulated blood usually appear immediately after, or within two days after, the accident; and that those formed of brain-matter occur at a later period, usually, although not necessarily, when the first or active inflammatory symptoms are on the decline. Facts do not, however, bear out any such rule. The blood-tumour may show itself at a period much later than that mentioned by Mr. Guthrie. In Abernethy's case, for instance, it did not appear until the tenth day after the removal of the bone. And necessarily such a tumour must vary very much as to the time of its appearance. Being, in some cases, dependent on blood extravasated at the time of the accident, the protrusion may occur at a very early period; being, in other cases, dependent upon blood extravasated, from various causes, into the soft and over-luxuriant granulations, it cannot come into existence until later. And the protrusion of true brain-matter—and by this is not meant the escape of brain-matter which immediately follows the accident or the operation—may appear within three or four days. I have seen it on the fourth day.

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* Op. cit. p. 138.

What is the course of such tumours? Varying in shape and in size, according to the hole in the dura mater through which they have to pass, such tumours gradually increase in bulk, and sometimes form a large mass, overlapping and completely covering the wound in the scalp; in their progress, portions break down, become sloughy, and disappear; and, under favourable circumstances, the whole tumour may thus, in the course of time, waste away, and cicatrisation of the wound follows; or, as the daily wasting takes place, further protrusion ensues, going on and on for days and days, until the patient dies; and, in some rare cases, such a protrusion has been brought suddenly to an end by the patient tearing away the whole tumour, and recovery has ensued. And experience has also proved that the protrusion may shrink, waste away, and at last disappear totally without any sloughing.*

But in the majority of cases the patient sinks, sooner or later, under the inflammatory processes going on within the skull. And hernia cerebri is certainly a most formidable, and most frequently a fatal, affection; not so much, however, on account of the protrusion, as on the circumstances which gave rise to it. Still there are on record a goodly number of cases in which patients recovered even after very large protrusions. Indeed, in one case, published by M. Spring,† the protrusion is said to have involved the whole of the left hemisphere; notwithstanding which, the patient got well, and lived for eleven years afterwards, and at the post-mortem examination the left side of the cranium is said to have been found quite empty.

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* Laurie, *Lond. and Ed. Month. Jour.* June 1844, p. 478.

† *De la Hernie du Cerveau,* 1853, p. 72.

As to the symptoms accompanying hernia cerebri, they are those of inflammation of the brain and its membranes, running its various courses, and such as exist without any protrusion. But, in some cases, large protrusions of brain-matter may be seen with daily sloughing and reproduction, and yet with but few symptoms, and those only slightly marked. In the case referred to at p. 165, of extensive protrusion from the anterior lobe of the right hemisphere of the brain, under the care of Mr. Cæsar Hawkins, at St. George's Hospital, the patient rambled a good deal, but, when spoken to, always readily answered every question put to him: there were some few and occasional twitches about the muscles of the face, and the motions and urine were passed unconsciously. The protrusion became larger and larger; portions of it sloughed away daily, and the only additional symptoms were an occasional fit of syncope, from which the patient soon rallied after taking a little wine, and some loss of power about the right arm: and this was all. The patient ultimately died from purulent infection.

The treatment of hernia cerebri is to be of the simplest kind. The less the protrusion is meddled with, the better. As a general rule, removal, either by tearing away, slicing off, or ligature, is to be avoided. The parts are to be kept as clean as possible, for which purpose, gentle syringing, either with cold water or some slightly astringent lotion, may be resorted to; and the best local application is that simply of cold water. In the earlier stages, when the tumour is but small, gentle pressure may be advantageous; but in the larger protrusions, it should be abandoned. The general treatment of such cases is that appertaining to intra-cranial inflammation, varying according to the symptoms and the condition of the patient.

And from all this it follows, that all causes which may lead to irritation and inflammation of the parts within the skull should, if possible, be carefully removed. No splinter, no depressed fragment of bone, no foreign body should be left, if it can be got away without undue risk. At the after-death examination of one case of hernia cerebri which fell under my notice, several pieces of bone were found firmly fixed to the outer surface of the dura mater, and there was one larger fragment, of a triangular shape, which had pierced the membranes, and was sticking in the brain. The same fact has been noticed, and especially dwelt upon, by several Surgeons.

Lastly, I would add, that we must be very careful, when operating, to avoid all injury to the dura mater. To admit of a protrusion of the brain, there must be, in addition to the removal of the bone, an opening of some kind in the dura mater. This membrane may not have been injured by the accident, but it may slough in consequence of being roughly dealt with at the time of the operation. We cannot, therefore, be too careful how we handle the dura mater whenever we are called upon to remove any bone; and to the evil of depriving this membrane of its outward covering we must be especially careful not to add that of unnecessarily touching and fingering it after an operation.

Injuries of the Cerebral Nerves.

In connexion with injuries of the head, one or more of the cerebral nerves are sometimes found seriously affected in their functions; and should the patient survive, this affection, however alarming at first sight, may sooner or later pass off altogether, or nearly so; or paralysis of the cerebral nerve may remain, and, in fact, be the only evidence of the patient having had a severe injury of the head.

Traumatic affections of the cerebral nerves may coexist with, and be produced by, very different injuries of the head.

The nerve may be torn or otherwise injured by the instrument which produced the fracture. This, however, is upon the whole a rare form of injury; but some nerves are by their situation and connexions rendered more liable to it than others. For instance, the olfactory, and more especially the optic and other nerves of the orbit, may be injured in a thrust-wound; and such wounds, although rare, are, as already mentioned, occasionally met with in civil hospitals.

Closely connected with, and passing through, holes and canals in the bones, the cerebral nerves may be torn or injured by a fracture implicating the base of the skull. And here again it will be found that some nerves are very much more liable to injury than others. Of all the cerebral nerves, the seventh pair, for instance, is thus injured much more frequently than any other nerves. This is easily explained by the relative frequency of fractures cutting across the petrous bone, and involving the long bony canal through which these nerves have to pass; and, for ages, paralysis of the facial or of the acoustic nerve has been held as a valuable sign of fracture of the base in severe injuries of the head. But, on the other hand, it must not be taken for granted, that in every such case of paralysis the petrous bone has been broken and the nerve torn. The paralysis may, after some little time, pass off, and then it is evident that the affection of the nerve must have been connected with some other form of injury. Other nerves are liable to injury from their close connexion with a piece of broken bone, and this, too, away from their bony canal.

Again, paralysis of the cerebral nerves may be dependent upon a traumatic effusion of blood at the base of the brain. And this extravasation may affect the nerve, either by pressing upon it in some part of its course, or by pressure upon the part of the brain connected with the nerve. The extravasation may ultimately be absorbed; and thus is explained that form of paralysis, not unfrequently observed about some of the cerebral nerves after an injury of the head, which lasts for a longer or a shorter period, and then gradually disappears.

The injuries of the various cranial nerves, viewed separately, present some points of especial interest, which must now be considered.

First pair. The olfactory may be torn across in a fracture of the base of the skull. It was so in a soldier in whom the ethmoid had been broken to pieces by a bullet.* But paralysis of this nerve not unfrequently occurs in cases where the head has been severely injured, without any direct evidence of fracture. In such cases we are led to suppose that an extravasation of blood was, in all probability, the cause of the paralysis of this nerve, and this extravasation may have affected either the nerve itself or the adjacent part of the brain.

In looking into these cases it will be found that the loss of smell followed such an injury as might lead to the anterior lobes of the brain being driven against the bones, and bruised. And, tightly bound down in the greater part of their course to the brain by the arachnoid membrane, the olfactory nerves may in this form of injury occasionally be more or less bruised, or pressed upon by an extravasation of blood. In one case mentioned by Sir B. Brodie,† a gentleman met with an injury of the head which deprived him of the sense of smell. After some time, however, he began to recover from this symptom, and at the end of a year his smell was completely restored. And in another case,* where the loss of smell also followed a severe injury of the head, this symptom persisted without the slightest improvement many years afterwards.

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* Jobert, *Plaies d'armes à feu*, p. 139.

† *Med.-Chir. Trans.* vol. xiv. p. 365.

In relation to the loss of smell, great care must be taken lest there be some error as to the existence of this symptom. In a case in St. George's Hospital, some years back, the patient, who was suffering from a traumatic paralysis of the face, appeared for several weeks to have lost the sense of smell upon the left side; even the strong liquor ammoniæ produced no effect, save that of lachrymation. At length it was discovered that, owing partly to a deflection of the septum towards the left side, and partly to the imperfect action of the muscles, the left nostril had, under ordinary circumstances, become impervious to air. On dilating the left nostril artificially, it was found that the patient could smell equally well on both sides.†

Second pair. The optic may be torn across in a fracture of the orbit. In the case of a child, over whose head a cab-wheel had passed, the roof of the orbit, in addition to other extensive fractures, was broken up into fragments, and the optic nerve and straight muscles were completely torn through.‡ This nerve is also so circumstanced that it may be pressed upon by a fragment of broken bone away from its foramen, so as to give rise to total blindness. Such was the case in an old man admitted into St. George's Hospital after having been run over by a cart. There was a fracture with depression of one of the parietal bones; but the most marked symptom was total blindness, which was explained, at the after-death examination, by the optic nerves, immediately behind the orbits, being pressed upon by the broken sphenoid bone.§

But loss of sight may also be caused by pressure from an extravasation of blood connected with a fracture of the base. And this extravasation may lie either within the skull or in the orbit.

In M. A. Richard's case,‖ with evident signs of fractured base of the skull, the orbits were filled with blood, and especially the left, on which side total loss of sight was observed on the following day. The blood in the orbits was gradually absorbed, and the sight of the left eye was completely restored within a month. In this case, the loss of sight was due, it was thought, to the blood extravasated in the orbit; but, in reference to this point, I would especially direct attention to the extravasation of blood which, after severe injuries of the head, sometimes takes place within the neurilemma of the optic nerve as it lies in the orbit. In severe injuries of the head, and especially those about the orbits, I have several times seen the neurilemma of the optic nerve distended with blood, which had evidently proceeded from the veins contained within this sheath. In the Museum of St. George's Hospital are two optic nerves, both taken from the same patient, in which these appearances are well marked. Such extravasations deserve, I think, more than a passing notice, for it seems to me that blood thus situated will serve to explain some of those cases in which blindness has existed for some time after an injury of the head, and then gradually disappeared. In such cases, the nerve-fibrils are not torn or injured; the neurilemma is simply cram-full of blood; and as this blood becomes absorbed, sight is restored. And thus it is that I would explain M. A. Richard's case. The orbit was, it is true, filled with blood; but as it is not stated that the effusion led to the least protrusion of the eyeball, I think it more than probable that the pressure of the optic nerve was from blood within its sheath, and not from the blood in the orbit. And then, again, it is expressly stated in this case that none of the other nerves of the orbit were affected, which they, in all probability, would have been, had the paralysis of the optic nerve depended solely upon the blood in the orbit.

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* *Med.-Chir. Trans.* vol. xiv. p. 421.

† *Med. Times and Gazette,* 1852, new ser. vol. iv. p. 240.

‡ *Bull. de la Soc. Anat. de Paris,* 1837, p. 228.

§ *Med.-Chir. Trans.* vol. xiv. p. 348.

‖ *Gaz. des Hôpit.* 1854, p. 446.

Third pair. From its connexions, the third pair of nerves is less liable to injury from broken bone than most of the other cerebral nerves. But it is liable to pressure from extravasated blood. A case of paralysis of the third nerve, in a fracture of the skull, is referred to by MM. Denonvilliers and Gosselin,* in which a clot of blood was found lying in the space between the crura cerebri. And Sir B. Brodie † states that he has "known a ptosis of the *left* upper eyelid connected with pressure on the inferior surface of the *left* hemisphere of the cerebrum; the pressure being so situated as to affect the nerve of the third pair immediately behind the left cavernous sinus."

After an injury of the head, all the branches of the third pair of nerves may be paralysed. But it is curious to observe how much more frequently it is a single branch of this nerve which is thus affected. For instance, there may be ptosis of the upper lid, and this may be the only part paralysed. Why one branch alone of this nerve should be thus singled out from all its other branches it would be impossible to say: not only may this be the case, however, but one branch of the upper division of this nerve, and another branch of its lower division, may be paralysed at the same time, without any of its other branches being affected. It is a matter of especial interest that we should note that there may be ptosis and a dilated, immovable pupil.

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* *Mal. des Yeux*, p. 821.

† Loc. cit. p. 351.

A gentleman* fell from his horse, received a severe contusion of the head, and was taken home labouring under manifest symptoms of pressure on the brain. When, after the lapse of several days, these symptoms became somewhat abated, it was observed that the pupil of the right eye was dilated, and incapable of contraction; but his power of vision was unaffected. This symptom was accompanied with a ptosis of the right upper lid, and a numbness of the right hand. Nearly a year elapsed before the pupil was restored to its natural condition.

A man † fell from a height and alighted on his head: amidst other severe symptoms, it was noted, four weeks after the accident, that the left upper lid was paralysed, and the left pupil dilated, with some impairment of the sight. The right pupil was natural. These symptoms gradually wore off; and the power of the upper lid, and the sight, were completely restored, within some thirteen months after the injury.

In both these cases it is especially worthy of note that the paralysis disappeared after a time. In the latter case it is mentioned that there was some impairment of the sight; and this might lead to the supposition that the optic nerve, too, was in some degree affected. There is no proof, however, that such an affection did in truth exist: the impairment of the sight may have been, and most probably was, owing to the dilatation of the pupil; but a simple contrivance—a card pierced with a small hole—would have settled this point.

Fourth pair. As to the pathetic nerve, I know of no case in which it was found torn or bruised in a fractured base. The relations of this nerve with the surrounding parts will easily explain this apparent immunity from direct injury; and, even were this nerve pressed upon by extravasated blood, with our imperfect knowledge of the action of the superior oblique muscle, the exact diagnosis of a palsy of this muscle would, I think, be most difficult.

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* *Med.-Chir. Trans.* vol. xiv. p. 354.

† *Lond. and Edinb. Month. Journ.* Sept. 1843, p. 797.

Fifth pair. Affections of this nerve have not unfrequently been met with after injuries of the head, the paralysis manifesting itself upon one or more of its branches, and this, too, combined, for the most part, with palsy of some other cerebral nerve.

A man,* aged 35, having, the day before, been buried by some earth falling in upon him, was admitted into the Hôpital St. Antoine, in June 1854, in a state of perfect insensibility, and with such profuse bleeding from the nose, that it became necessary to plug his nostrils. The ocular conjunctiva, especially on the left side, was distended with blood, and so, too, were the eyelids. He gradually recovered, and then paralysis of various nerves became evident at different periods. The right upper lid and eyeball lost all power of motion. A few days afterwards, and paralysis of the right side of the face was observed; it was not quite complete, but both sensation and motion were manifestly affected. Ten days after the patient had been in the hospital, the conjunctiva of the right eye was œdematous and much chemosed; the cornea could be touched freely without flinching; it had lost some of its transparency, and, at its lower part, there was a yellow spot like an interlamellar abscess. Towards the end of the month, the cornea presented a slight ulceration opposite to the yellow spot, and the facial paralysis was even more marked. Matters went on much in the same way during the month of July, with more ulceration, however, about the eye, and less paralysis of the face. Early in August the cornea gave way, and the aqueous humour escaped. Later on in the month the patient began to improve; subsequently the right cornea cicatrised, and he could see from the upper part; and, ultimately, both sensation and motion were restored to the right side. Such, as far as the fifth pair of nerves is concerned, are the details of this most interesting case.

One more case of palsy of the fifth pair. The man† was in St. George's Hospital in the year 1841. At the time of his admission, seven weeks after a very severe injury of the head, there was total loss of sensation on the left side of the face and upper part of the head—in fact, in every part dependent upon the fifth pair of nerves; there was no sense of taste or of feeling on the left side of the tongue, except at its root, and no consciousness of any sensation when a probe was introduced into the left nostril; and the muscles of mastication on this side had less power. Several other nerves were also seriously affected. His history was, that he had fallen from a height of twenty-eight feet, a heavy piece of timber at the same time falling upon the left side of his head. The accident was followed by perfect insensibility, for several hours, and the loss of a large quantity of blood from the ears, nose, and mouth; there had been paralysis of the right side of the body, but from this he had recovered. His intellect was sound, and he answered all questions with great precision. Very little improvement followed, notwithstanding various plans of treatment. The power of raising the left upper lid was regained, but the cornea of the left eye gradually became opaque. And when seen, many years afterwards, this man was much in the same state, save that the cornea had become somewhat more transparent.

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* *Gaz. des Hôpitaux*, 1854, p. 446; A. Richard.

† *Med. Times and Gaz.* 1852, p. 240; Henry Lee.

Such is traumatic paralysis of the fifth pair of nerves; caused in some instances, no doubt, by pressure from extravasated blood, and in other instances again by some more permanent injury; at times passing off within a few weeks, at other times abiding year after year. The cases which have been mentioned were, moreover, especially selected in reference to the subsequent condition of the cornea. In the first case, in which the affection of the nerve was incomplete, and passed off altogether within four months, the cornea sloughed; but in the other case there was no sloughing of the cornea, notwithstanding the perfect palsy of many years' standing. Both cases afford good examples of the two forms of diseased action referred to in Mr. Dixon's* valuable paper on anæsthesia of the fifth nerve.

Sixth pair. Paralysis of the abducens nerve occurs sometimes after an injury of the head; it may exist alone, or be combined with paralysis of several other branches. The sixth nerve may be torn across in a fracture of the base; indeed, its close connexions with the petrous bone render this nerve liable to direct injury. From its slender size, and passing as it does in a groove on the superior border of the petrous bone, the sixth nerve may be snapt across in a fracture of this part of the base.

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* *Med.-Chir. Trans.* vol. xxviii. p. 373.

A man* fell from a height, and alighted on his face. He never lost his senses; merely felt shaken, walked home, and returned to his work next day. Four days afterwards, however, he began to suffer from head-symptoms, and three weeks from this time it was noticed that the right eye was drawn inwards. He went on from bad to worse, and died at the end of four months. A fracture was found running across and detaching the inner third of the right petrous bone, and opposite to this the sixth nerve was snapt asunder.

In this case, the sixth was the only nerve injured; and thus it was also in another instance, mentioned by M. Aran,† in which a man, after receiving a violent blow on the head, lost all power of moving the eye outwards. There was a distinct squint, for which he was operated upon by M. Maisonneuve; but with very little or no benefit.

Paralysis of the abducens not unfrequently coexists with that of some of the other cerebral nerves. Of this there are several cases on record, in which this nerve, as well as the others, gradually regained its power.

Seventh pair. As for the facial and the acoustic, paralysis of these nerves is one of the common signs of fracture of the base of the skull. Connected as these branches are with the petrous bone, they may be, and are frequently, torn across in a fracture implicating this region. And although so closely connected—bound up in the same sheath—lodged in the same canal—one of these nerves may be injured, and not the other. Facial paralysis not unfrequently exists without deafness; and sometimes there is marked deafness, without any affection of the muscles of the face. The paralysis may be strongly marked, but it may pass off in a few months. In such cases the injury may have consisted in an extravasation of blood within the tubular sheath of the arachnoid belonging to these nerves. I have seen a small clot of extravasated blood lying between the nerves, at the bottom of the meatus internus.

Eighth and ninth pairs. Affections of these nerves occur but seldom after injuries to the head. The bony canals through which these nerves pass are short, and the nerves themselves lie in the region of one of the large sub-arachnoidean spaces, the fluid of which would, by its displacement, allow room for blood to be extravasated without any great amount of pressure.

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* *Journ. l'Expér.*, nov. 1843.

† *Arch. Gén. de Méd.*, nov. 1844, p. 338.

Should an affection of these nerves thus occur, however, the symptoms, in such cases, are certainly most distressing; but, however distressing, they are not always fatal, and they may even disappear altogether. A forcible illustration of this will be found in the two following cases.

In one instance[*] mentioned by Mr. Hilton, with paralysis of some other cerebral nerves, it is particularly noticed that the patient manifested much difficulty in swallowing; the tongue was thrust over to one side; articulation was slow, and enunciation very imperfect; and there was pain extending down the neck, on the side affected, as far as the clavicle. The patient had bleeding from the ears, nose, and mouth, after an injury of the head; but he recovered in a few months, and with only slight traces of paralysis left.

A grenadier[†] was struck in the region of the posterior superior angle of the left parietal by a lance, which passed deep into the substance of the brain. The lance was withdrawn a few hours afterwards, and the wound healed rapidly. The intellect was as good as it was before the injury, but the glosso-pharyngeal, the par vagum, the hypoglossal, spinal-accessory, and sub-occipital, were all paralysed. Aphonia, dysphagia, dyspnœa, with contractions of the muscles accessory to respiration,—more or less paralysis of the pharynx, œsophagus, and stomach,—so that large doses of emetics had no effect;—such were some of the most distressing symptoms presented by this poor fellow.

One more case, in which the eighth pair of nerves became affected, must be mentioned, as it shows what consequences may arise by subsequent displacement of the fractured bones in an injury of the base.

A man[‡] was admitted into Guy's Hospital with symptoms of concussion of the brain, and fractured base of the skull. He went on well until the tenth day, and then, after getting out of bed, and walking across the ward to talk to his wife, he was seized with rigors and vomiting, and gradually fell into a semi-unconscious state. Towards the evening appeared difficulty of swallowing, and the breathing became gasping. The difficulty of swallowing increased; and before the morning, every thing was rejected as soon as it reached the pharynx. He died of coma and asphyxia, within forty-eight hours after the setting-in of the serious symptoms. The brain and its membranes were healthy; there was no appearance of any thing like inflammatory action; neither was the brain bruised or lacerated. A line of fracture intersecting the right foramen lacerum posterius, and running across the base, divided this part of the skull into an anterior and a posterior portion, freely movable upon each other; and the bones here were so displaced, that the right cerebellar fossa was lower than the left.

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[*] *Lancet*, 1853, vol. i. p. 421.

[†] Chassaignac, *Plaies de Tête*, p. 93.

[‡] *Lancet*, 1853, vol. i. pp. 24, 25, 147.

In commenting upon this case, Mr. Hilton very justly remarks, that the difficulty of swallowing and breathing, which suddenly made its appearance after the man's walk across the ward, was, in all probability, caused by the displacement of the bones at the foramen lacerum posterius—a displacement by which the eighth pair of nerves was irritated, if not severely pressed upon. And as there was not the slightest trace of inflammation about the brain or its membranes, this, no doubt, is the right explanation of the symptoms which so suddenly made their appearance.

And this view of the case is borne out by Sir C. Bell's* two cases, in which sudden death was caused by the after-displacement of fractured portions of the foramen magnum, and consequent pressure upon the medulla oblongata.

Special treatment in injuries of the cerebral nerves seems to be of but little avail. If dependent upon extravasated blood, or any other cause removable by the efforts of nature, the paralysis will gradually disappear in the course of time; but I know of no particular plan of treatment which will help us much in such cases. At least, mercury, blistering, and other remedies usually resorted to, have not, as far as I have seen, produced any very marked benefit. And in using electricity, we must be very careful lest it produce disturbance about the head, which it is apt to do, especially if employed at too early a period after the injury. On the whole, I should, in all cases of traumatic paralysis of the cerebral nerves, trust much to the restorative powers of nature.

TRAUMATIC INFLAMMATION OF THE BRAIN AND ITS MEMBRANES.

All injuries of the head, of whatever kind, may lead to inflammation within the cranium. Injuries of the scalp, apparently of the most trifling nature; injuries of the bones; injuries of the brain-substance;—all may give rise to intra-cranial inflammation. But some of these injuries are more apt to give rise to this inflammation than others, and, as might be readily anticipated, injuries of the brain-substance are, more frequently than any other injuries, followed by this kind of mischief.

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* *On the Nervous System*, 3d edit., cases cxlvi.-cxlix.

In a wound of the scalp followed by erysipelas or diffuse cellular inflammation, cerebral symptoms often supervene; and should the patient die, the morbid appearances in the majority of cases are limited to great congestion of the brain-substance, with increased vascularity of the pia mater, and effusion of opaque fluid in the sub-arachnoid tissues at the upper surface of the hemispheres.

Inflammation spreading inwards from an injury of the bone or of its coverings may be traced, as it were layer by layer, from the outer parts down to the brain; first involving the dura mater, then the parietal arachnoid, the visceral arachnoid, the pia mater, and ultimately the cortical substance of the brain.

The inflammation of the dura mater may be marked by increased vascularity, thickening, and closer adhesion to the bone; such appearances belong, however, more especially to a chronic form of mischief set up by inflammation, caries, or necrosis of the bone after an injury. In the more acute inflammation, and above all in suppuration of the osseous tissue, the outer surface of the dura mater is covered by lymph, or by pus; its tissue gets infiltrated; it may pass on to sloughing. As far as the dura mater itself is concerned, the mischief is generally confined to that part of the membrane directly under the diseased bone; but even here, in particular localities, it sometimes happens that the inflammation spreads along the cellular tissue which surrounds the branches of the meningeal arteries, and by this means reaches even down to the base of the skull.

In the acute cases, the inflammation, involving as it does the whole thickness of the dura mater, lays hold also of its inner surface, the parietal arachnoid, a part and parcel of the dura mater; and having once reached this serous membrane, the inflammation usually and rapidly becomes wide-spread. The inflammatory effusion on the free surface of this membrane is but very seldom limited to the spot first implicated. This I have, however, seen once. Under an exposed piece of bone, the dura mater was inflamed, thickened, and partially detached; and exactly limited to this spot, there was an effusion of lymph and pus on the parietal layer of the arachnoid; but all the other parts of the membranes and of the brain were quite healthy.

This is an exceptional instance, and in the vast majority of cases the parietal arachnoid is extensively inflamed, and the cavity of this membrane is filled with a quantity of fibrinous or of puriform exudation of a yellowish or yellowish-green colour. The effusion seldom extends, however, beyond the upper and lateral surfaces of the hemispheres; sometimes it spreads over one hemisphere only, that corresponding to the injured bone; sometimes it is found on both hemispheres, but without any effusion at the base of the skull. Occasionally, the puriform is circumscribed by the fibrinous effusion, which may, moreover, unite the two layers of the serous membrane to each other around this part; and thus is formed within the arachnoid that kind of circumscribed collection of matter which may be, and has been, mistaken for an abscess in the brain-substance. As an instance of this, I would more especially refer to De la Peyronie's* celebrated case of abscess of the brain, which was, I think, simply a collection of matter circumscribed in the cavity of the arachnoid, and running down by the side of the falx, as far as the corpus callosum. This view of the case is, I think, borne out by Pott's† and Soulier's‡ cases, and by a case in which I found a collection of matter in the cavity of the arachnoid thus circumscribed and running down between the left hemisphere of the brain and the falx, as far as the corpus callosum. The depth to which the matter passed in this case might easily, during life, have led to the supposition that the collection was in the brain itself.

From the arachnoid the inflammation spreads to the pia mater, and here, too, there is an extensive fibrinous or puriform exudation of a yellowish or yellowish-green colour. The meshes of this membrane are filled with the effusion; and such is the thickened condition of the pia mater, in the severer cases, that it may be removed whole from the brain, and with its prolongations, which dipped down between the convolutions, looks as if it had been cast in wax. Of this there are excellent specimens in the Museum of the Royal College of Surgeons, and in that of St. George's Hospital.

As in the arachnoid, so here, in the pia mater, these appearances do not generally extend beyond the convexity of the hemispheres. And all that part of the cortical substance of the brain corresponding to the inflamed and thickened pia mater is often of a dark, leaden hue; it may be, too, adherent to this membrane, and softened, and easily torn; so that, in endeavouring to pull off the pia mater, it not unfrequently happens, notwithstanding all our care, that patches of brain-substance, varying in size and thickness, come away with the membrane.

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* *Mém. de l'Acad. des Sc.* 1741: "Sur le Siége de l'Ame."

† *Inj. of Head*, p. 107.

‡ *Mém. de l'Acad. de Chir.* t. i. p. 159.

In all this, the gray matter alone, and sometimes only a thin layer of it, is involved: as to the white substance of the brain, it is simply congested, the bloody puncta being larger and more numerous than usual.

Such are the usual appearances when inflammation spreads inwards from an injury of the bone or its coverings. But occasionally it happens that the appearances in these cases differ somewhat.

On the one hand, there may be extensive effusion into the cavity of the arachnoid without any effusion in the pia mater: thus, in a case where matter was lying between the bone and the dura mater, the corresponding cavity of the arachnoid was filled with pus and lymph, covering the posterior third of the upper and lateral surface of the hemisphere, but there was no effusion in the sub-arachnoid tissues. Of this there are two equally well-marked cases mentioned by Dr. Watson;* but according to my own experience, such cases are very rarely met with.

On the other hand, with an inflamed dura mater, covered, it may be, with lymph and pus, it sometimes happens that the arachnoid escapes, and this, too, notwithstanding an extensive effusion in the sub-arachnoid tissues. In a case in which the dura mater on the left side was covered with a patch of concrete lymph, and matter running from thence along the branches of the middle meningeal artery down to the base of the skull, no effusion was found in the cavity of the arachnoid; but there were large quantities of sero-purulent fluid in the sub-arachnoid tissues covering the whole of the left hemisphere.

Such a case is a very uncommon one. There is no doubt that, in the great majority of instances of meningitis arising from an injury of the bone, the inflammatory effusions are poured into the cavity of the arachnoid. But how very rarely is any thing like exudation met with in the arachnoid in the idiopathic form of inflammation! And when this marked difference between traumatic and idiopathic arachnitis is spoken of, it must be borne in mind that it is especially in this form of traumatic inflammation, arising from an injury of the bone, that the great difference exists. Traumatic inflammation of the membranes arising from an injury of the brain resembles the idiopathic form of inflammation, inasmuch as the cavity of the arachnoid is, in both forms, most frequently free from effusion.

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* *Pract. of Phys.* 3d ed. vol. i. pp. 368, 369.

In looking carefully to the inflammatory appearances of the membranes after concussion or contusion of the brain, the exudation will, for the most part, be found on the outside of the arachnoid, and more or less extensively infiltrating the pia mater. It is only in cases where the inflammation is very severe that effusion takes place on the free surface of the serous membrane. The exudation itself resembles that which is commonly found in inflammation of the pia mater; if puriform, it is greenish, and not unfrequently of a decidedly green colour.

There are, then, two kinds of traumatic inflammation of the membranes of the brain. The one, commencing in the dura mater, and almost always reaching the free surfaces of the arachnoid; the other, commencing in the pia mater, and seldom passing beyond this membrane, and that only when the inflammation is very severe. The one, starting as it were from the bone, affects the membrane nearest to it, the dura mater; and the other, starting from the brain, here also affects the nearest membrane, the pia mater. Whilst dealing with concussion of the brain, it was particularly mentioned that intense vascularity is one of the peculiar features found about the brain-substance when death takes place some short time after the accident; and well can it be imagined that this intense congestion of the brain, if it does not pass off, will react on the pia mater; and hence the inflammation which, in such cases, manifests itself in this membrane.

Injuries of the head may also lead to inflammation of the brain-substance itself; and this traumatic inflammation may affect either the cortical substance only or the deeper parts of the brain. Inflammation of the cortical substance may follow an injury of the bone, as in those cases, for instance, in which the inflammation may be traced through the various membranes to the brain, the gray substance of which, of a leaden hue, is softened, and easily carried away in peeling off the membranes. This, doubtless, is an inflammatory process affecting the cortical substance.

Traumatic inflammation of the cortical substance may also be detected in those cases where meningitis supervenes after simple concussion of the brain. Even at an early period the inflamed gray matter, of a dark-red hue, is swollen and soft, thin patches of it coming away with the pia mater, which itself is very vascular. Later on, effusion takes place in the pia mater, and the gray matter, of a darker colour, breaks up and washes away under a gentle stream of water, leaving bare the white matter, much increased in vascularity, but not softened. This inflammation of the gray matter is remarkable for its extent; in many cases it occupies a whole hemisphere save the base, which generally remains unaffected.

But inflammation of the brain most frequently follows contusion and laceration of its substance. Simple concussion seldom leads to fatal inflammation, and rarely does an opportunity happen of examining the after-death appearances in a case of this kind. In the great majority of the so-called cases of concussion in which death takes place, the inflammatory process is found to be connected with, and arises from, an actual and appreciable lesion of the brain-substance.

Should the patient survive the accident for a few hours only, the whole structure of the brain, and especially that around the injured part, becomes extensively congested; so that it will require some little care to distinguish between the specks of extravasation and those of congestion. At a later period, the brain-tissue around the injured spot is of a duskier hue throughout, and the texture swollen, moist, and loose. Then follow the inflammatory exudations, reducing the substance of the brain around to a soft pulp of various colours, which flows away under a gentle stream of water, leaving the remaining part broken down and shreddy. These appearances do not generally extend much beyond the original seat of the injury; but sometimes the greater part of the hemisphere becomes involved: the white substance is then of a peculiar saffron colour, which grows fainter and fainter on the outskirts, and the whole tissue is loosened and diffluent; and even should this appearance of disintegration not be at first sight plainly perceptible, it may easily be demonstrated by dropping upon the part a little water from a sponge.

Softening of the central white parts of the brain is very seldom met with after an injury of the head. The following are the only two cases which have fallen under my own observation. A man, aged 37, died twenty-four hours after an injury of the head in a fall from a tree: the ventricles were found dilated and filled with fluid, and the fornix—remarkably soft—gave way when slightly touched: at the base of the brain, around the pons and medulla oblongata, there was a large quantity of milky puriform fluid: the substance of the brain was firm, and the puncta of blood larger and more numerous than usual: the cribriform plate of the ethmoid was broken, and the corresponding part of the brain bruised. A lad, aged 13, died, about three weeks after he had been thrown from a donkey and fallen on the back of his head. The ventricles were enormously dilated, and filled with serum and recently-effused lymph, and the central white parts of the brain were very soft, and broke down when slightly touched; the gray and the white substances of the brain were, throughout, very much congested, and there was extensive inflammation of the membranes; a slight fissure was found in the occipital bone, extending from the lateral sinus to the foramen magnum.

All traumatic inflammations of the brain-substance may end in suppuration and abscess, and this after contusion and laceration, and even after simple concussion. Of this I have seen two well-marked instances at St. George's Hospital within the last few years. In both cases the abscesses were large ones, and in both the formation of matter followed simple concussion.

An abscess, situated in the brain, may burrow, and burst into the ventricles: such an occurrence soon proves fatal. But an abscess in the neighbourhood either of the cribriform plate of the ethmoid, or of the petrous bone, may, by making its way through these bones, ultimately be discharged by the nostrils or by the ear, and the patient get well. In these cases of recovery we cannot, it is true, say positively that the matter came from the brain itself; it may have come from between the bone and the dura mater, or from a circumscribed cavity within the sac of the arachnoid. Still, if the discharge which takes place is copious, it may, I think, be safely inferred that the matter came from the brain itself, as a large quantity of matter is more apt to form in this than in either of the other situations just mentioned. The abscess may be situated close to the surface of the brain, and, moreover, it may chance to lie over a fracture; so that the matter would only have to make its way through a thin layer of brain-substance and the membranes.

The copious discharge of matter which suddenly took place from the ear, some weeks after an injury of the head, in Mr. Cæsar Hawkins' case, may thus have come from the brain. In his report* of the case, Mr. C. Hawkins inclines to the opinion that the matter came from between the bone and the dura mater; but there are two important facts which appear to me to militate against this opinion. The one, that diffuse inflammation of the membranes almost constantly accompanies suppuration between the bone and the dura mater; and the other, that had the matter really been between the bone and the dura mater, and percolated through a fracture, it would have come away gradually as it was formed, and not in a sudden burst—in a large quantity. This it is which makes me think that the case was one of cerebral abscess which had made its way outward.

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* *Med. Gaz.* vol. xvii. p. 262.

Intimately connected with this subject of traumatic intra-cranial inflammation, there is yet one other point which has not, I think, been sufficiently dwelt upon by most of the writers on injuries of the head. I allude to the large quantities of serous fluid which are sometimes effused into the ventricles after injuries of this kind.

Fluid is poured out into the ventricles, after an injury of the head, under very different circumstances. The effusion may occur, and this is generally the case, in connexion with other mischief of a more deadly nature, with acute inflammation of the membranes. For instance: in a man who died three days after having been trephined for a compound and depressed fracture of the skull, the sub-arachnoid tissue of the upper part of the left hemisphere was extensively infiltrated with sero-purulent fluid, and all the ventricles were enormously distended, and filled with a clear, transparent serum; the lining membrane being, throughout, rough, and as if sprinkled with the finest white sand. The septum lucidum was exceedingly thin. The structure of the brain was quite healthy.

But accumulation of fluid within the ventricles, following an injury of the head, may sometimes be the only morbid appearance; and this effusion may be more or less gradual: days, weeks, months, may elapse before any decided symptoms make their appearance.

Of such cases Dr. Abercrombie relates two strongly-marked instances in his work on *Diseases of the Brain*, pp. 151, 152. In both these cases the effusion was slow, and the symptoms came on gradually. But the effusion may take place suddenly; symptoms of imminent pressure are present, and, with a scalp-wound and bare bone, may lead to an error in diagnosis, and the application of the trephine.

A middle-aged man fell in the street, and was picked up insensible, with some arterial bleeding from a scalp-wound at the upper and back part of the head; the bone was not exposed. He remained in a state of collapse for some time, and when he began to rally he became so violent that two men were obliged to hold him down. It appeared that, on the previous day, he had had, for the first time in his life, some kind of convulsive fit, but without any frothing at the mouth. He was freely purged, and on the following day, as he complained of intense pain in the head, he was bled to ten ounces. The pain continued, and thus he went on for several days with intense pain, notwithstanding that he was bled several times and put upon calomel and henbane. On the sixth day, the bone under the scalp-wound became exposed, and the soft parts in the neighbourhood slightly œdematous. On the seventh day, early in the morning, this man was seized with hiccough, and suddenly fell into a state of coma; the insensibility was complete; the pupils acted well; there was no stertorous breathing; the pulse was feeble and running. A short time afterwards, it was determined, at a consultation of several Surgeons, that a trephine should be applied over the exposed bone, in case there should, perchance, be any matter between the bone and the dura mater. No matter was found. The bone and the dura mater were healthy. The patient continued much in the same state, and died in the evening. Some serous effusion was found between the arachnoid and the pia mater, especially at the base of the brain; there was no lymph in any part; the membranes were quite transparent, and the pia mater not congested. The ventricles were dilated, and filled with a large quantity of fluid; the brain itself was watery throughout, and soft. In one of the convolutions, at the base, there was a small tubercular deposit, of the size of a pea, and around this the parts were soft and injected to about three lines in circumference. No tubercular matter was found in any of the other organs, which were all sound.

What are the symptoms of traumatic intra-cranial inflammation? Amongst the first symptoms usually noticed will be pain in the head, more or less intense, sometimes confined to the seat of the blow, sometimes spreading from this over the whole head; feverishness, with a hot skin and increased pulse; contraction of the pupils; intolerance of light and of sound. As matters get worse, these symptoms increase, become more and more marked, and are soon followed by disturbance of the brain-functions; sickness, restlessness, constant tossing about, convulsions, delirium; then drowsiness, oscillation and dilatation of the pupils, twitchings and spasms of the muscles, coma, relaxation of the sphincters, paralysis, and, as indicative of suppuration, rigors.

Such are the varied symptoms at different stages of inflammatory mischief following an injury of the head. In some cases all these symptoms may be present, and even manifest themselves in this regular order of succession. But in most cases the symptoms vary much in many respects. Cases may be met with in which some of these symptoms are altogether wanting; and in other cases, again, a single group of symptoms, or some one symptom or another, may be strongly marked. Indeed, in practice, it will be found that these variations give, as it were, to each case special features of its own—features which may render the case more or less difficult of diagnosis as to its real nature.

In enumerating these symptoms, injuries of the head have been spoken of as a whole. And now arises the question, whether traumatic inflammation dependent upon one form, can be distinguished from that dependent upon another form of injury. Can it be said, in this case, that the brain alone is affected, and in that case, that the mischief is confined to the membranes? I believe not.

In a case of concussion and scalp-wound, it cannot, for instance, be said positively, from the symptoms, that they depend upon inflammation of the brain-substance and its investing membranes connected with the concussion, or upon inflammation of the parietal membranes connected with a contusion of the bone. Neither can we say positively, when suppuration takes place, that the matter is immediately under the bone, or within the brain-substance. True it is that this cannot be done. But an inference, and a good one too, may, I think, be drawn from the time at which the symptoms of inflammatory mischief begin to show themselves. If the inflammatory symptoms are dependent upon concussion, they will be apparent at a very early period after the accident; indeed, in many cases they begin within a few hours: and this is what might have been expected from the intense congestion which exists in the brain-substance and its investing membrane, the pia mater, after a severe case of concussion. In contusion of the brain-substance, on the other hand, it often, nay generally happens that the symptoms of inflammation do not set in till the fourth or the fifth day; all effects of the injury may appear to have passed away up to that period, and then comes the train of symptoms indicative of inflammation. But in inflammation spreading from a contused bone to the parietal membranes, the mischief may smoulder for a time, for many days, for two or three weeks, and then suddenly burst forth.

The period at which the inflammatory symptoms begin after the accident may, then, be of value in our endeavours at establishing a diagnosis, and especially if there be any local signs about the bone to guide us.

Attempts have been made at a differential diagnosis of inflammation of the various parts and structures of the brain. Inflammation of the upper and under parts of the brain may be, it is said, distinguished from each other; and so, too, it is said, may inflammation of the lining membrane of the ventricles, as well as inflammation of the cortical, be distinguished from that of the tubular structure.

I cannot, however, say that I think we are at present really in a position to go so far as all this. To take an example from two of our modern teachers. "Inflammation of the tubular portion of the hemispheres is characterised by the appearance of convulsions previous to any sign of mental excitement." Such is Mr. Solly's* opinion. And Dr. Watson's:† "When the attack comes on with a sudden fit of convulsion, the inflammation has commenced in the pia mater, or arachnoid." Can any thing illustrate more forcibly the difficulties by which we must be surrounded whenever we may attempt to draw an accurate diagnosis of the exact parts of the cranial contents involved in an inflammatory attack?

It must be borne in mind that convulsions, that is, convulsions violently affecting the whole body, may make their appearance, after an injury of the head, under very different circumstances. They may come on immediately, or shortly after the accident; they may come on a few days after it. In the first instance, they can, as a matter of course, have nothing to do with inflammation; they may pass off just as suddenly as they came on, and leave the patient without a single sign to denote that they arose from any actual lesion of the parts contained within the skull. And even in the second instance, making their appearance at the period when inflammation usually sets in, the convulsions may lead us to suppose that there is inflammation, when it does not exist in reality. This I have seen now and then, and some well-marked instances of this state of things are mentioned by Sir B. Brodie.‡

Next, we have to deal with the treatment of this traumatic intracranial inflammation. And first as to blood-letting. Strange it is to read of the enormous quantities of blood drawn from patients, under such circumstances, in former times, and even but a few years back. Some cases, it is true, recovered after this heroic treatment, and nothing short of this, it is said, could have saved the life of the patient. But the practice of the present day in the wards of our large hospitals tells a very different tale. For years past, I have never seen any of those frightful blood-lettings which I used to witness in the early part of my career. Even in intra-cranial traumatic inflammation we are nowadays much more sparing of blood—and rightly so, too.

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* *On the Brain*, 2d edit., p. 457.

† *Lect. on the Pract. of Physic*, 3d edit., vol. i. p. 384.

‡ *Med.-Chir. Trans.* vol. xiv. p. 367.

Whenever blood is to be drawn from the arm, the general condition of the patient should be carefully looked to, and, if the loss of a few ounces only of blood produce an intermission, a sinking of the pulse, the blood should no longer be allowed to flow. The patients with whom we have to deal in the present day certainly do not require, neither could they, I think, bear the loss of much blood. I am speaking now of the patients, such as I find them, in the wards of our London hospitals. They, at any rate, certainly do not require much blood-letting. If it be thought absolutely necessary to draw blood from the arm, it had better be done by small bleedings, repeated at intervals according to circumstances. It is on all accounts better to act thus circumspectly than to try to cut short the inflammatory attack by large bleedings. And in every one of our bleedings, not only ought we to look to the general condition of the patient, and the state of the pulse, but most careful should we be to examine the blood, not so much for the sake of seeing whether it is buffed and cupped, as for the relative proportions of the solid and fluid parts of the blood. A large amount of serum with a small clot tells us that we cannot with safety proceed further with our bleedings.

Some years ago, I watched a case wherein repeated bleedings, within a short time, were resorted to for supposed intra-cranial inflammation after concussion. A few hours after the last bleeding, which, although a small one, appeared to me, when ordered, not to be required, the patient suddenly became perfectly comatose, and died some nine hours afterwards. There was not a vestige of pus or of lymph in any part within the skull, but large quantities of water had been effused into the ventricles, and some water was also found in the sub-arachnoid tissues. The other organs were all healthy. I have always thought that this patient died of over-bleeding.

In many cases, after the first bleeding from the arm, it is most advantageous, should further blood-letting be deemed indispensable, to resort to local bleeding by means of leeches applied to the head, or cupping on the nape of the neck. It was a favourite practice with Sanson to have leeches applied "en permanence," in different parts of the head, at different times; and especially on the temples, and over the mastoid processes.

As a matter of course, the room is to be darkened, the head shaved, and raised higher than usual.

Purging, free purging, is to be brought into play as soon as possible. It is a most valuable remedy, and one upon which all practical men very justly lay great stress, and none more so than Dr. Abercrombie, who does not hesitate to say that, according to his own experience, more recoveries from head-affections of the most alarming aspect take place under the use of very strong purging, than under any other mode of treatment.

And then comes the local application of severe cold to the shaved head. This is a powerful remedy, and not to be used without all due caution, for the effects of it are sometimes most striking. If thought necessary, pounded ice, or the cold douche, are the means the most readily obtained and used in such cases.

One of the earliest remedies should be mercury, calomel in small doses, and frequently repeated until the gums begin to be affected. Is opium to be combined with it? About this there is great diversity of opinion. By some Surgeons, opium in these cases is strongly condemned; by others, it is used without scruple. I have frequently seen calomel and opium prescribed in traumatic inflammation of the brain and its membranes, by some of the most practical and best Surgeons, and I must say, without any of the drawbacks, as far as I could perceive, so commonly adverted to. And opium, or, better still, morphia, is doubtless of great value in many cases presenting some of the most characteristic symptoms of inflammation. In furious delirium supervening a few days after an injury of the head, with well-marked symptoms of an inflammatory attack, calomel and morphia are of the utmost use. Of this, abundant proofs are to be found in the best authorities; and practically, I have several times witnessed the beneficial effects of these remedies in such cases.

Antimony I have always avoided. I know that it is frequently used by some Surgeons of great eminence; but I have always been afraid of the vomiting which it might produce. It is an uncertain remedy in this respect, and I have often seen even a small dose produce sickness.

Are we to use blisters? Not, I think, in the first stage. Later on they often prove most beneficial, and may be applied over the head, or nape of the neck. The French Surgeons, however, and especially Boyer, advocate the early use of a blistering-cap to the head. And should a blistering-cap have been thus applied, great benefit may, occasionally, be derived from the use of mercury to the blistered surface, which, in fact, is to be dressed with mercury.

In estimating any plan of treatment in cases of inflammation after injuries of the head, great care must be taken to examine thoroughly into the state of the different viscera, and especially of the kidneys. This is a point to which I have already more than once adverted; and feeling as I do, from practical experience, the absolute necessity of not overlooking this matter, again do I allude to it in this subject of traumatic inflammation.

A healthy or a diseased condition of the kidneys may not only lead us to modify our treatment, but our views of the case in hand, knowing, as we now do, how it sometimes happens that the very symptoms about the head are dependent upon the diseased condition of these viscera.

If recovery takes place after intra-cranial inflammation, the patient should be put upon his guard against running any risk of a relapse; and especially should he be cautioned about his mode of living, and his future habits for some time to come. There is, it is well known, no class of cases which require more after-care, and none in which a relapse is so apt on the slightest provocation to take place.

But, notwithstanding all our endeavours, the inflammation may get ahead; symptoms of pressure follow; and then comes the question of applying the trephine.

In discussing the question of perforating the skull in contused bone, and in fractures with symptoms of intra-cranial suppuration, it was settled that the dura mater is to be divided if there are evidences of matter underneath this membrane; that is, if the dura mater, tense, and without any pulsation, bulges into the trephine-hole; and some cases were mentioned in which the patient's life had been saved by this proceeding,—cases in which circumscribed suppuration had occurred within the arachnoid. But nothing was said about the treatment of abscess within the brain-substance, such abscess not being necessarily connected either with contusion of the bone or with fracture.

An abscess may form in the brain after any and every kind of injury of the head; and it is with this abscess, which may give rise to the symptoms of pressure, that we have now to deal.

In such a case it may occur that the matter in the brain is let out by simply taking away a piece of the bone, the dura mater underneath being in a sloughy condition. Thus it happened in a case at St. George's Hospital, a few years back, under the care of Mr. Cæsar Hawkins. The trephine was applied over an exposed portion of the left parietal for well-marked symptoms of compression of the brain which had come on a month after the accident. The operation was performed under the supposition that matter would be found between the bone and the dura mater: but such was not the case; the dura mater proved to be in a sloughy state, with an opening, of the size of the thumb, through which escaped a quantity of very foul matter and brain-like substance. The man died five days after the operation; and then was found in the back part of the left hemisphere a good-sized abscess, extending down to the lateral ventricle, into which it had nearly burst.

It happens more frequently, however, that the dura mater is not in this sloughy state. One is led by the symptoms to divide this membrane, and then, finding that this affords no relief to the symptoms, is one warranted in cutting into the brain in search of an abscess? The warrant in such a difficult matter necessarily depends upon the circumstances. Should there be good reason for believing that a cerebral abscess exists under, or in the neighbourhood of, the part of the skull perforated, there is no doubt that one would be warranted in incising the brain.

Roux* laid open the dura mater, and finding nothing under this membrane, proceeded no further. The symptoms increased, and the patient died in a few days. Immediately under the cortical substance of the brain was a large abscess, situated a little below and behind the spot trephined. The matter might easily have been reached by a very slight cut in the brain at this part, and in such a case, with decided symptoms of compression, one may well regret that no attempt at all was made to find the matter.

J. L. Petit† was more fortunate in the issue of his case of traumatic abscess of the brain. This celebrated Surgeon trepanned the head of a child, nine years old, for a compound fracture with depression. Feverish symptoms set in on the fifth or sixth day; on the following day the wound was dry, and the dura mater, of a darkish-brown colour, bulged into the trephine-hole: evidently there was matter under the dura mater; this membrane was divided, and a tablespoonful of brown, fetid serosity escaped. The symptoms were not relieved by this operation, but nothing further was done. Matters went on from bad to worse, and there was but little hope left, when, on the second morning after the operation, the little fellow appeared to be much better. The improvement which had taken place was explained when the head was dressed; a large quantity of foul pus was found in the dressings, which were saturated with it, and this had come from a large abscess in the brain, which had burst during the night. The patient was quite well within two months afterwards.

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* Chassaignac, *Plaies de Tête*, p. 192.

† *Mal. Chir.* t. i. p. 91.

It was the fortunate issue of this case which, doubtless, led M. Velpeau[*] to recommend delaying the incision into the brain whenever the symptoms are not very urgent. In thus delaying, M. Velpeau thinks that if matter existed in the brain, it would, in all probability, gradually push its way towards the trephine-hole, and, at any rate, render the operation less hazardous.

Dupuytren,[†] far from waiting thus, at once plunged a knife into the brain, and thereby, in all probability, saved the life of his patient. A young man was struck on the top of the head, in a brawl, with a knife, the blade of which broke in the bone, after having perforated the skull; but the exact nature of the injury was overlooked by a Surgeon, who simply brought the lips of the wound together. The wound healed readily, and every thing went on well for several years, save some occasional pains about the scar. This man was subsequently admitted into the Hôtel Dieu in a state of stupefaction, into which he had suddenly fallen. On examining the scar, a foreign body was clearly felt underneath it, and this, when laid bare, proved to be the point of the knife. The trephine was applied; the symptoms nevertheless continued, and paralysis of the opposite side of the body made its appearance. The dura mater was now laid open; nothing was found under this membrane; a knife was therefore plunged into the brain, and immediately a large quantity of matter flowed out. That very night all the symptoms disappeared, and the patient ultimately recovered.

Dupuytren's bold proceeding was followed by complete success. And so, too, might De la Peyronie[‡] have been equally successful, had he been allowed to do that which he wished. A man was trepanned, and a large quantity of matter was evacuated from under the bone, with great relief to the symptoms. On the second morning, however, the symptoms were as bad as ever. De la Peyronie laid open the dura mater, and, finding nothing there, proposed cutting into the brain; but this was declined. The patient died.

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[*] *Plaies de Tête*. 1834, p. 87.

[†] *Bless. par Armes de Guerre*, t. ii. p. 146.

[‡] Sabatier, *Méd. Opér.* 1832, t. ii. p. 65.

An abscess was found in the brain at the depth of three or four lines, and immediately underneath the opening in the skull.

And within the last few years, a Surgeon* has been bold enough not only to make several different cuts into divers parts of the brain for a traumatic abscess, but even to lay open one of the lateral ventricles for the evacuation of matter therein contained. In this case a man, aged 40, met with a severe compound fracture of the skull, and ultimately lost several pieces of the frontal bone. He did well; but five weeks after the removal of the bone, cerebral symptoms made their appearance. The scar was laid open, and three more pieces of loose bone were taken away. The symptoms still persisting, Dr. Detmold was led to think that there was an abscess in the brain.. The scar was now dissected off, with the portion of the dura mater to which it was attached; an incision an inch long and half an inch deep was then made into the brain-substance, and a thick stream of healthy pus flowed out. The symptoms were at once relieved, and the patient progressed most satisfactorily until hernia cerebri occurred. This was kept down by pressure; and on the eighteenth day after the opening of the abscess, the patient was about, a hole through which a probe could be passed into a cavity in the anterior lobe of the brain still remaining. Three weeks afterwards, although he felt very well, this man began to lose his memory; he even forgot his own name, and could no longer read nor write. The parts involved in the injury became hot and swollen, and stupor reappeared. A fresh incision was made through the integuments into the brain, but this time no matter followed; the symptoms, however, appeared to be greatly relieved. Dr. Detmold probed the wound, and found that the instrument passed four inches and a half into the brain towards the lateral ventricle, into which it was thought that the abscess had burst. The patient continued to mend for a time, but five days afterwards he became speechless. It was then thought advisable to explore for more matter; and seven weeks after the first incision, another one, an inch and a half deep, was made into the brain, and a probe passed in nearly five inches. Shortly after, matter flowed freely through the wound. The patient sank the same evening. Both ventricles contained a large quantity of thin pus, and at the anterior corner of the roof of the left one there was the last incision. The brain itself was vascular, and nothing more.

There are many bold deeds in the records of surgery appertaining to injuries of the head, but Dr. Detmold's must be classed amongst the boldest. The first incision certainly saved the man from impending death; and, in the state that he was subsequently in, it might be argued that he was none the worse off for the other incisions, which offered him the only chance of safety, if chance of safety there was. Few Surgeons will, however, be found to follow Dr. Detmold's example.

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* *Amer. Jour. of Med. Sc.*, N. S., No. 37, p. 86.

PRESCOTT HEWETT.

INJURIES OF THE BACK.

PROVISIONS IN THE STRUCTURE OF THE SPINE AGAINST INJURY.

ACCIDENTS to the vertebral column derive their chief importance from the dangers which result to the spinal cord contained within it, either at the time or subsequently. Before proceeding to treat of these, it may be of advantage to take a survey of the structure, in order to be reminded of the parts most subject to injury, under the varieties of exposure to violence.

As a portion of the skeleton, the spine serves different uses, some of which appear inconsistent with the others: it is a beam, or girder for connecting different members of the body; a support to the ribs in breathing; a pillar for sustaining the weight; an elastic, jointed mechanism for motion; and a case for protecting the most delicate and vitally important organ next to the brain, viz. the medulla spinalis. The security which belongs to the spinal cord depends mainly on the column being fittingly elastic, and having a nicely graduated flexibility. From consisting of numerous bones, all of which, as they are piled one above the other, rest on three distinct points of support, a force applied to the pillar in any single part is immediately diffused in many different directions; the cushions of intervertebral substance, interposed between the bodies of the vertebræ, act as so many buffers to break the suddenness of collisions; the oblique processes are shaped as wedges, and are opposed to each other with their sharp edges reversed, so that as the one slides downwards upon the other, the bases of both wedges approximate, and the descent is thereby gradually impeded: again, by the overlapping, like scale-armour, in alternately opposite directions, of the two sets of oblique processes, the vertebræ are so interlocked, each with the bone above and below, that only a slight degree of motion is permitted between any two adjoining vertebræ, while extensive motion may take place in several together. Then, in conformity with the column being flexible in various degrees at different parts, there are introduced, to equalise the movements at the points of junction, a succession of slight curvatures:—for example, the vertebræ of the dorsal region, from sustaining the ribs, possess but slight mobility, while the cervical vertebræ above, on which the head is poised, are peculiarly flexible; hence it is arranged that the cervical vertebræ, where they unite with the dorsal, shall form a curve, the convexity of which is directed forwards; by that means a force falling on the lower vertebræ of the neck is diffused through a succession of different joints, each more inflexible than the other, till it is finally lost in the dorsal portion, oppositely encurvated. In a similar manner, the vertebræ of the lumbar region, which, from being at the base of the column and supporting the whole superincumbent weight, and from being connected with an immovable foundation, the sacrum, are especially subject to strains and jars, have a curvature, with its convexity forwards, which answers as a sort of arched spring to break concussion. The next provision for the safety of the spinal cord is found in the mode of its being secured to the interior of the canal. The medulla is of small dimensions compared to its bony case; then, the arachnoid membrane, instead of being in close contact with the cord, surrounds it loosely, and the intervening space is occupied by water,—the subarachnoid fluid; the arachnoid membrane, thus enclosing a layer of water around the cord, is safely tacked to the internal surface of the proper sheath, or theca, by the ligamenta denticulata; and the theca itself, the prolongation of the dura mater of the brain, is attached loosely to the inside of the osseous canal: for although, at the top of the column, it adheres firmly to the borders of the foramen magnum, it is connected generally by those processes alone sent off laterally on the roots of the nerves, as they emerge successively at the intervertebral foramina. Accordingly, the medulla may be said to float on a water-bed; and that bed is hung from the sides of the canal by cords not unlike those by which the sailor suspends his hammock to the cabin's roof. The last instance of the provisions for the security of the spinal cord that may be adduced, is presented in its mode of termination in man. In quadrupeds, from the spine being horizontal, and supported equally by the fore and hind legs, the lumbar region is not exposed more than other parts to strains or pressure; and it appears that, in correspondence with that freedom from danger, the medulla is continued within it to the sacrum. But in man, of adult age, the length of the organ is curtailed; it ends abruptly at the second lumbar vertebra. For a short distance above that point, the cord is thickly enveloped in the origins of the nerves of the lower extremities; but below, the canal is occupied merely by the bundle of miscellaneous roots, anterior and posterior, which form together the cauda equina. It would appear that this arrangement was designed to avert from the medulla those dangers to which it would have been exposed, had it been continued down to the end of the canal in the sacrum. From the whole weight of the body bearing upon the lowest lumbar vertebræ, and from the column enjoying greater freedom of motion there than elsewhere, it is manifest that the bones in that situation are more liable than above, to sudden jolts and jars of a severe kind: it is apparent, therefore, that shocks which would be harmless to the loose, cord-like structures composing the cauda equina, would be destructive to the functions of an organ of such delicate and soft consistence as the spinal cord.

Yet, admitting that all parts of the mechanism of the spine display admirable adaptations for the defence of the spinal cord, and for accommodating it to its other offices, the union of mobility with stability, in an erect pillar destined to support weight, implies the introduction of an element of weakness; and we shall find that certain parts are, therefore, more vulnerable than others. The points of greatest weakness are those at which a flexible region joins on to one that is relatively inflexible. Observation has shown, that of the whole spine, the portions most liable to fracture are the cervico-dorsal and the dorsi-lumbar parts respectively; at each of which a transition, from a structure that is supple, to another that is stiff, or *vice versa*, takes place. The proneness of the column to give way at these situations Sir C. Bell aptly illustrated by the breaking of a fishing-rod: if, in throwing his fly with a long cast, the trout-fisher snap his rod across, the fracture will be found, not at the middle of any of the pieces, but at one of the joints; that is, the bending force, which, if the rod had been equally flexible throughout, would have been diffused uninterruptedly over its whole length, is arrested at the site of the brass socket, which does not partake of the flexibility; it is, therefore, concentrated there, and the wood breaks near the junction.

SPRAINS OF THE BACK.

Selecting for our consideration, in the first place, the more ordinary and less dangerous injuries of the spine, sprains claim early notice. They are usually caused by a person falling from a height, or by a heavy weight coming down unexpectedly on his neck and shoulders. For example, a bricklayer recklessly leapt from the top of a newly-built four-storied house on a thick heap of sand upon the ground; and having alighted on his buttocks, he did not suffer any more serious injury than a bad sprain at his loins. Another instance was that of a navvy working in a railway cutting; a mass of earth, having become loosened over his head, fell principally on his shoulders, and, as it buried him, caused him to receive a severe sprain in his back. The effect of accidents of such a kind is, that the vertebral column is violently and extensively curved forwards; and as the lumbar is not only the most flexible region, but from being at the base of the pillar, has the whole superincumbent weight thrown upon it, the strain will be greatest at that part. We may also conclude that, in consequence of the weak condition of the articulations at the dorsi-lumbar junction, adverted to above, the force of the injury will be severely felt in the vertebræ there.

To form an accurate estimate of the amount of lesion from such extreme flexion, we must take into view the difference in the effects produced on the structures, according as they are situated at the convex or the concave side of the curvature. The extensive bending of the column may be looked on as a near approach to the act of breaking; and it is known, from the laws of mechanics, that when a beam of timber, which may represent the spine, is broken by being greatly bent, the force engaged has a distinct effect on three different portions of the timber. Dividing the beam into three equal parts, that on the convex side of the curve resists fracture through the tenacity of its textures; the third on the concave side resists through the density of its fibres; and the intermediate part is in a neutral condition, neither over-stretched nor compressed; at least, so long as the parts on each side preserve their integrity. Applying the same principle to the spine when bent forwards to an extreme degree, short of being broken, it will be understood that the structures (muscles, tendons, ligaments) lying on the posterior side of the pillar will be subject to a process of over-stretching; those in front to one of compression; and that the spinal cord, occupying the central, neutral space, will be exempt from injury. Now, by the term sprain it is implied that the accident has not been so severe as to implicate the medulla. Accordingly we may expect to find evidences of the fibrous structures generally, in the lower half of the back, having been strained, and perhaps even partially lacerated. These include the lumbar fascia, the tendinous expansions, the intermuscular septa, the tendons themselves, and the ligaments, particularly the interspinous ligaments. As to the ligamenta subflava, it may be supposed that, owing to their central situation and elasticity, they escape being ruptured. Again, upon the concave side, the intervertebral substances will undergo compression, especially on their anterior borders; but as they are protected by their toughness and resiliency, they do not suffer greatly. There are, however, situated on each side of the spine, at the very place where the chief flexion takes place, the kidneys; which are not unfrequently injured by the sudden bending and compression. (For the symptoms of this lesion, see INJURIES OF THE ABDOMEN.)

Together with the over-stretching and, it may be presumed, the laceration, of the textures on the posterior surfaces of the spine, there will be ecchymosis; but as the blood is extravasated principally in the deeper structures, beneath the aponeuroses, and as the integument is peculiarly thick, it does not usually show itself for several days. Very early after the accident, considerable tumefaction takes place in the whole region of the loins, accompanied with other signs of inflammation. The patient suffers a great deal of pain, aggravated by his attempting to raise the body from the bent into the erect position. He is incapable of walking, except with the support of others, or by resting the weight of his body on his arms by grasping both knees; he lies in bed on his side, with the body slightly bent forwards; and it is an agony for him to have to turn round.

Prognosis. In the majority of cases of sprain of the back, it may be anticipated that after confinement, with appropriate treatment, to bed or sofa for a week or fortnight, the patient will be able to get about; but it is probable that several additional weeks will pass before he loses all stiffness and pain. This continuance of the effects of the injury sometimes gives rise to the apprehension lest, by chronic inflammation extending to the deep parts of the spine, either caries of the vertebræ, or a morbid thickening of the membranes of the spinal cord, should supervene. Experience, however, does not warrant us in entertaining such fears. Disease of the spine, ending in angular curvature, it will presently be seen, is essentially a constitutional disorder; and although, when lurking in the system, it may be provoked and become manifest after an injury to the back, like that of a sprain, the latter cannot be alleged to have originally brought it on. Again, in reference to thickening of the membranes of the cord, accompanied, perhaps, with degeneration of the structure of the medulla, producing paraplegia, it may be admitted that such consequences can, in some cases, be traced to violent sprains: but the same morbid conditions are met with where no such accidents have previously occurred; and the proportion of cases in which a sprain is followed by such bad effects is so small, that in ordinary practice we are entitled to give a favourable prognosis.

A question may arise as to the subsequent effect on the kidneys, when they have been squeezed and partially torn by sudden, extreme flexion of the spine. For example, from the falling-in of a house, a woman was bruised in the loins; she died afterwards from Bright's disease of the kidneys; and a medico-legal question was started in the courts of law, whether the injury had a share in inducing the fatal disease. Pathologists have not hitherto been able to establish, that any particular morbid process is set up as a sequence of compression or bruising of the substance of the kidney. It is commonly found, in those cases of sprain of the loins where the urine is mixed with blood, that the discoloration of the water lasts only for two or three days; and that, when it ceases, no further bad effects ensue.

Treatment. When a man receives a bad sprain in the back, the injury is commonly attended with so much general concussion to the body, that he may be, at first, in a state of collapse; which will probably raise the question, whether some internal viscus, the liver or bowel, may not have been ruptured, and internal hæmorrhage be taking place. A short delay is therefore often called for, before the appropriate treatment can be commenced. That will consist, speaking generally, of antiphlogistic measures, constitutional and local. After an active mercurial purge, a dose or two of Dover's powder may be given, with salines at intervals. The diet ought to be spare. In those of vigorous constitution, the abstraction of blood may be required. Afterwards, nothing will conduce more to the comfort of the patient than well-managed fomentation of the back; using for that purpose a piece of soft, nearly worn-out blanket, covered first with thin oil-cloth, to retain the moisture, and then with dry blankets to retain the warmth. If the pain be unabated, lead-lotion and opium may be added to the poppy fomentation. Another plan may be successfully adopted; viz. covering the part with thick compresses of cotton-wool, soaked till moist with a lotion consisting of the tincture of arnica, in the proportion of an ounce to the pint of water, and laying over it gutta-percha tissue. Amendment will be denoted by the patient's turning in bed more freely, and seeking to sit up. At that period, stimulating liniments, or the application of the compound tincture of iodine, will be called for. When able to walk, he will be benefited by a warm plaster to his loins. Before leaving his couch, stays, like a riding-belt, stiffened with steel ribs, may be provided as a support.

FRACTURES AND DISLOCATIONS OF THE SPINE.

In what follows, it is proposed to treat, first, of the injuries of the column as they are confined to the bones and joints; secondly, of the effects on the spinal cord within.

A preliminary remark may be made in regard to associating fractures and dislocations of the vertebræ in the above title. As a general statement, it may be held true, that when a man, according to the common expression, has his "back broken," these two kinds of injuries accompany each other. It need not be denied that dislocation occasionally takes place without fracture, or *vice versâ*. It is, nevertheless, almost invariably found that, when the displacement of the vertebræ is considerable, and the case appears one of dislocation alone, some portions of the bones are broken; and that when fracture is the principal injury, there is dislocation, partial or entire, of one or other of the joints. That combination is readily understood when we take into account the irregular forms of the vertebræ, and the over-lapping of their various processes. In the dorsal region the bones are so closely locked, and the processes, especially the spinous, so long and overhanging, that simple dislocation appears impossible; but in the cervical and lumbar regions, where motion is free, and the articular surfaces are either more horizontal than vertical, or the processes stand out apart, a considerable amount of dislocation may take place, accompanied with but little fracture. For example, a case has been related by Mr. Holmes, of a man struck on the loins by a heavy log of timber; the last dorsal vertebra had been dislocated from the first lumbar, with laceration of the intervertebral substance; but the fracture of the processes was so inconsiderable, that the fact of their having been crumbled, rather than broken, might easily have escaped notice.*

And, practically, the question of the proportionate amount of fracture compared with dislocation, is in most cases of little moment. It would be founding on a false analogy to suppose that, because it is important in a case of accident to the hip, shoulder, elbow, &c., to recognise distinctly the nature of the injury, whether it be fracture or dislocation, the same thing held with regard to the spine. What renders injuries of the back of gravest interest to the Surgeon, is the question of the condition of the spinal cord; and that organ is equally liable to be crushed, and have its functions destroyed, by fracture, or by dislocation. As to the treatment, if reduction of the displaced bones be required, the method of effecting it will be the same in both kinds of injuries; and as to prognosis, the prospect of recovery is not more or less encouraging in the one than in the other.

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* *Pathol. Soc. Trans.* vol. x.

The forces which cause fracture of the vertebræ (comprehending in that term, for the convenience of expression, partial dislocation) are necessarily violent; they also fall upon the flexible column in many different directions; and they produce thereby a great diversity in the injuries. It will simplify the subject, if we distinguish fractures, into those which come from *indirect*, and those which come from *direct* violence. Injuries affecting the two highest vertebræ, as they have certain special characters, will be considered afterwards by themselves.

On fractures of the spine from indirect force. A standard example of this kind would be presented, if a man were subjected, in an extreme degree, to the same description of violence which, if less severe, would have caused a sprain in the back similar to what has been lately treated of. A miller's carman, standing in his wagon, was receiving into it heavy sacks of corn, let down by ropes from the high story of a granary; the fastening of one of the sacks slipped, and it descended, lighting on his neck and shoulders: his spine was fractured at the fifth dorsal vertebra. A young gentleman, nineteen years of age, being on an apple-tree, the branch on which he sat broke, and he came to the ground on his nates, which left their impression on the soil; the spine was broken at the eighth dorsal vertebra. A man, falling headlong from a height, came to the earth upon the vertex; bruises of the scalp were visible at that part, and it was found that he had fracture of the lowest cervical vertebra. All these cases are examples of the spine broken in a transverse direction, consequent on the column having been bent to an excessive degree; and that by forces bearing upon the column, not in the line of the fracture, but along the longitudinal axis. In examining the body of a person who has died shortly after such an accident, the following appearances will be observed. Blood will be extravasated extensively in the neighbourhood of the fracture. At the lumbar region, one or two of the supra- and interspinous ligaments will be ruptured, and a gap be thereby produced between the corresponding spinous processes; at the dorsal region, a chipping-off of the slender ends of these processes will more probably be met with. There will be partial laceration of the muscles and tendons in the vertebral grooves, at the seat of the fracture. Proceeding more deeply, the plates of the two vertebræ most involved in the injury will be found more or less extensively separated from each other; and the ligamenta subflava will be seen with ragged edges torn off from the margins of one or other of the laminæ. The condition of the articulating processes will differ in the several regions; in the dorsal, the ligaments connecting them will be torn, and they themselves will almost certainly be broken; in the cervical, the ligaments will be ruptured, and the processes, whether much fractured or not, will be dislocated; but this dislocation will probably be transient; the surfaces of these processes, being comparatively broad, and nearly on the same horizontal level with the bodies of the vertebræ, frequently fall into their places again after the separation; thus constituting it a case of *diastasis*, rather than of dislocation. In the lumbar region, the articulating processes will be wrenched asunder, like teeth drawn from their sockets; but when the vertebræ settle down, the processes will not return to their original situations; one or both will hitch upon some point of the subjacent vertebra, on which they can rest; the bones will thus be locked, and permanently displaced; there will be a distinct bend, accompanied with a twist of the spine, and the transverse processes of one side will project visibly against the skin. Consequent on the separation of the articulating processes and the simultaneous rupture of the ligamenta subflava, the interior of the vertebral canal will be opened, and the sheath of the spinal cord, probably obscured by extravasated blood, exposed. Omitting at present to speak of the medulla spinalis itself, attention may next be drawn to the state of the front of the column, viz. the bodies of the vertebræ and intervertebral substances. In treating of sprains, the remark was made that, when the spine was incurvated forwards, the force which operated on the fore part, being the concave side, was one of compression. Accordingly, in cases of fracture, such as we are considering, it is to be understood that the injurious effects will be due to crushing, in contradistinction to tearing. It might, perhaps, have been thought that when the powerful ligaments and other structures at the back of the spine had been rent across, and the superincumbent weight thrown exclusively upon the bodies and fibro-cartilages, the latter parts, being of comparatively soft consistence, would have been torn through, or detached from the surfaces of the bones. But in indirect fractures, such a laceration of the intervertebral substance is rare; a fact which may be accounted for from the line in which the force of compression is exerted being vertical instead of transverse. The great injury inflicted is the breaking down of the body of the particular vertebra which is situated at the angle of flexion. Seldom are the bodies of more than one bone fractured. And the kind of fracture is a combination of the 'comminuted' and 'impacted.' With the fracture of the body, the longitudinal ligaments in front and behind are torn through. In some instances, the upper fragment glides a short way downwards and forwards upon the lower, and in that manner overhangs it: but, owing to the locking together of the processes behind, that motion is soon arrested, and the displacement is never considerable. In others, a triangular-shaped portion of the body, having become loose, has been thrust back, owing to the compression being greatest in front, with the force of a wedge, into the vertebral canal, so as to encroach on the space for the spinal cord.

On fractures of the spine from direct force: dislocation. Owing to the spine being protected on its fore part by the throat, chest, and abdomen, it is not liable to be injured by direct force, except from behind. Again, when direct violence sufficiently great to cause fracture is applied, it makes the column bend backwards, before breaking; or, in the opposite direction to the incurvation which precedes its being broken by indirect violence. Hence there is a corresponding contrast in the power which, according to the mechanical law formerly referred to, resists fracture in the anterior and posterior structures of the column respectively. The former, including the bodies of the vertebræ and the intervertebral cartilages, yield by being torn; the latter, consisting of the arches and processes, succumb by being compressed.

As the vertebræ of the dorsal region have a natural curvature anteriorly, and are besides, except in early life, so firmly locked together as to be nearly inflexible, we cannot expect that they will be bent greatly in a posterior direction. But the case will be different in the cervical and lumbar regions. In each of these the natural curve is backwards, and the vertebræ are also highly flexible. We may conclude, therefore, that when either part is subjected to direct violence, and the incurvation is increased beyond the normal point, so that fracture ensues, the bodies of the vertebræ will be divorced from each other, and the intervertebral cartilages stripped off from their surfaces; but that the posterior arches, together with the articular, transverse, and spinous processes, will be compressed, ground, and crushed. From this it will be seen how much more likely dislocation is to enter into the composition of a direct, than an indirect fracture. If one of the intervertebral substances have been torn, and the bodies of the corresponding vertebræ been set entirely loose, there will remain only the joints of the articulating processes to hold the bones together; and when these have been broken asunder, nothing, it appears, will be left to limit the amount of separation between the ends of the vertebræ. The case, related by Mr. Holmes and already adverted to, of dislocation at the dorsi-lumbar part, illustrates this view. The patient had been struck on the loins by a heavy piece of timber, and been immediately affected with paraplegia: the lowest dorsal vertebræ were observed to be half an inch in advance of the level of the lumbar vertebræ; by extension, the bones were restored, with an audible click, to their proper places: after death, the fibro-cartilage between the last dorsal and first lumbar vertebræ was found to have been ruptured, and the anterior common ligament stripped off the body of the latter bone; the articular processes on both sides had been separated, and there was partial fracture of the transverse processes. In a case of dislocation between the same vertebræ, described, with a drawing of the specimen, by Sir Charles Bell,* and in which the child survived for thirteen months, the injury was also direct; it had been caused by the wheel of a stage-coach passing over the body.

In connexion with this subject, it may be noticed that the two lowest vertebræ of the loins are shielded from the effects of direct injury. Both these bones are flanked on each side by the posterior parts of the ossa ilii, which project backwards beyond their level; hence, if a blow from an obtuse object be inflicted in a line corresponding to them, it will be expended on the pelvis. Accordingly, dislocation or fracture of either of these two vertebræ, from direct force, is unknown.

Of injuries to the spinal cord consequent on fracture. When the vertebral column is broken across at any point between the occiput and the second lumbar vertebra, where the medulla spinalis terminates, that important organ partakes of the injury; it is deprived of its functions; and all the body below the fracture at once loses, more or less completely, both motive power and sensation. In technical language, the patient is affected with paraplegia.

From this statement it will be perceived that the higher in the spine the fracture occurs, the graver will be the consequences. But before attending to the differences in the effects referrible to the extent of the body paralysed, let us examine the lesions produced in the spinal cord itself and its membranes, from the injuries.

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* *Observations on Injuries of the Spine and of the Thigh-bone*, 1824.

Owing to the small size of the medulla, it is seldom destroyed partially; the columns which give motion, and those which give sensation, are almost always deprived of their functions simultaneously. The mode of destruction differs in various cases. 1. When the displacement of the vertebræ has been extreme, the theca has been found torn through, and the cord itself ruptured, with the ends separated to a distance of two inches from each other. 2. In many cases the medulla is intruded upon by the sharp edge of an angular fragment of vertebra; the theca and other membranes are penetrated, and the organ itself cut and torn across: in the majority of such cases, the fragment which projects into the canal is a part of the body, and is therefore situated in front. 3. In the cervical region, when the vertebræ have been both torn from each other and extensively bent, the cord may be found not only crushed but burst; from the violence of the squeeze, the pia mater will have given way, and the medullary substance, converted into a thin pap, will have escaped and be spread on the surface of the organ above and below the rupture. 4. The structure of the cord is not unfrequently disintegrated through its whole thickness, and the appearances on dissection will not be such as to indicate, at first, serious injury: from the pia mater being entire, the organ may retain its natural figure, or there may be a slight swelling alone visible, without discoloration; but when the finger is carried along the surface, with the view of judging of its consistence, and comes to the part corresponding to the seat of fracture, the cord will be felt soft, as if broken; and on a section being made, the medullary and cineritious matter will be found diffluent, commingled and stained in the centre with blood. Lastly; in regard to the terminal portion, where the cord gradually tapers to a point in the midst of the congeries of roots which hang down in the canal as cauda equina, observation of the results of various cases of fracture in that situation would lead to the belief that the roots in some degree protected that part, or that the chief injuries which it sustained consisted of laceration of its surface, from one or more of the roots having been overstretched and detached.

In lesions of the spinal cord, the hæmorrhage is generally slight; and it differs in all cases, both in its mode of occurrence and effects, from what is met with in injuries of the brain. The arteries and veins which permeate the medulla are remarkable for their minute size: hence, when a portion is cut or bruised, the bleeding soon stops, and extravasation on the surface, or ecchymosis in the substance of the organ to a considerable amount, is rare. If the latter take place, it will be greatest in the central cineritious matter. The hæmorrhage encountered in fracture of the spine proceeds chiefly from laceration of the large venous plexuses which line the interior of the vertebral canal. The blood collects on the outside of the cord and its membranes; and as the theca adheres rather firmly in front, but on the lateral and posterior parts somewhat loosely, to the canal, the accumulation of blood is commonly greatest behind and at the sides.

Fractures in the Lumbar, Dorsal, and Cervical Regions, distinguished by the Varieties in their Effects.

Consequences of destruction of the spinal cord from fracture stated generally. When a man has met with an injury of such severity as to give rise to fracture of the spine, there is a general shock to his nervous system, and he is found, at first, in a state of profound collapse. When restored, he complains of pain at the seat of the injury, especially if any attempt be made to move him. The tumefaction at the painful part, together with irregular projections and depressions in the processes of the vertebræ, divulge the nature of the accident. It is soon perceived that his whole body below the level of the fracture is completely paralysed. If a line, corresponding to the distribution of the nerves which come off immediately above that part, be drawn around his chest or abdomen, he will be incapable of feeling, when pricked or pinched, in any part of the skin from that line to the soles of the feet; he will be unable to move any joint of his limbs; there will not even be reflex actions of the muscles. The urinary bladder will have lost the power of expelling its contents; and as the kidneys go on secreting the ordinary quantity, it will ere long be over-distended. As the patient is not prompted by the natural call to pass his water, the bladder will at length be elevated as high as the umbilicus, feeling like a hard globular body, and giving out a dull sound on percussion. The fæces will also be retained; at first, with obstinate costiveness; afterwards, the stools will pass involuntarily; but the patient will not be aware of their escape, or of their presence when they lodge on the bedclothes. There will be priapism. The temperature of the paralysed parts will be the same as that of the body generally.*

In whatever region of the spine the fracture may have taken place, these are the consequences, if the patient live, of the spinal cord having been deprived of its functions. But, as remarked before, there will be a difference in the extent of the body paralysed, according to the height in the column at which the lesion has occurred.

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* March 4th. While these sheets have been passing through the press, a brewer's drayman, aged 35, was admitted, 23d of February, into the Hospital, under the writer's care, with fracture of the fourth dorsal vertebra.

Fracture below the second lumbar vertebra. The spine may be broken, and the fracture attended with great displacement, below the second lumbar vertebra, and yet there will be no paralysis whatever of the lower extremities, bladder, or rectum. The writer has had the opportunity himself of observing four cases of that kind, and he has recorded the particulars of them.* In all the cases, the distortion which immediately followed the injury was visible to the eye, the trunk being bent forwards at an angle, and the spinous and transverse processes projecting against the skin. Notwithstanding these undoubted signs of fracture, accom-

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When standing on his car, a bag of hops, weighing a hundred-weight and a half, fell from a height of forty feet upon his head and shoulders. From an inch below the nipples there was loss of sensation; and the lower part of the body was paralysed as to motion. No reflex actions could be observed, on the first day. On the third, he could faintly distinguish which foot was pricked with a pin; and in one toe, a slight motion was induced by tickling the sole: but no further change in these respects was afterwards observed. On the second day, he had tympanitis; and his respiration, which had been impaired before by a slight bronchitic affection, became distressed; a constriction, or furrow of the ribs above the lower margin of the chest, not visible before, being apparent. The dyspnœa, with an audible rattle from mucus, gradually got worse; his face became red and lips purple; and delirium, at first slight, but afterwards high, seemed to keep pace with the imperfection of his breathing. From the beginning, there was priapism. Although two hours and a half before the accident, he had made water, the catheter, used three hours afterwards, drew off eight ounces. The average quantity withdrawn daily (at intervals of six hours) has been forty-two ounces. Till the seventh day, when the quantity was sixty ounces, the urine has been intensely acid, yielding lithates abundantly: it was then, but only for a short time, alkaline, and gave off an ammoniacal odour: mucus was also noticed for the first time. On the second day a calomel and jalap purge, some time afterwards followed by an enema of turpentine and rue, were given, without bringing away a motion, or diminishing the flatulence. Sixty hours after the accident the bowels acted copiously, and what passed was healthy; on the following days he has had frequent evacuations, of natural appearance, without medicine. The temperature was examined by the thermometer. No difference could be perceived between that of the sound and the paralysed parts of the body; it was almost constantly 103°, once 106°. On the seventh day a slight blistering on the nates was observed for the first time; but it has not yet turned to a bed-sore. For the last two days he has had profuse sweats, confined to the upper part of his body. He is now moribund.

* See *London Medical Gazette*, vol. xvii., and *Transactions of the Pathological Society of London*, vol. iii. p. 420.

panied with partial dislocation, the patients retained sensibility and the power of motion in their lower extremities. Some of them walked, with the assistance of persons to lean upon, for a considerable distance, directly after the accident. All eventually recovered, with more or less deformity remaining. The explanation which the writer gave of the absence of paralysis in each of these cases was, that the injury had fallen on a part of the spine below that to which the spinal cord had descended. As already stated (see page 198), the cord, in man at adolescence, does not reach lower down than the second lumbar vertebra. Below that point the canal is occupied only by the cauda equina and its membranous sheath. Now, the roots of the nerves which compose the cauda possess considerable firmness of texture; they are also suspended loosely together. Accordingly, they are capable of bending or slipping aside, in correspondence with any displacement of the vertebræ, so as to elude injury and retain their functions.

Fracture in the dorsi-lumbar region. By mounting a short way higher in the column to the part wherein the tapering end of the cord, surrounded by the roots of the cauda equina, is contained, we arrive at the situation of the last dorsal and first lumbar vertebræ. It has been previously explained that, owing to particular causes, the spine is peculiarly subject to be broken, dislocated, or both together, in that portion. When either of these injuries happens, accompanied with great displacement, complete paraplegia, and the usual unfavourable issue, may be anticipated. But it will be found, on examining numerous recorded cases, that the paralysis is not unfrequently partial at first; or that either motor or sensory power, or both, are soon restored; and that the cases of recovery are in greater comparative number here than in other localities. The inference to be drawn from that observation is, that the spinal cord, as suggested before, is defended from the effects of displacement of the vertebræ, by being covered on all sides by the roots of nerves which form the cauda equina; and that the partial character of the paralysis is probably owing to laceration of a certain limited number of the roots, at their origin from the cord.

Of fracture in the two lower thirds of the dorsal region. Between the fourth upper and second lowest dorsal vertebræ, fracture occurs in any part with equal frequency. And when the column is broken across in this situation, the paralysis that ensues may be expected, owing to the comparative smallness of the cord and narrowness of the canal, to be complete. If the fracture be low in the part specified, the patient will encounter the risks of sloughs on the back, and general disease of the urinary organs. These subjects will presently be treated of by themselves. If the fracture be high, his life will be further endangered from impairment in the actions of respiration, consequent on the parietes of the abdomen, and a large number of the intercostal muscles, being paralysed. Yet it may be put forward as a partial counterpoise to these imminent dangers, that, from the inflexibility of the dorsal region, and the ribs on each side serving as kinds of splints, the original displacement of the fragments is not ordinarily great; and that the probability of union being quickly effected (which is of utmost importance for the proper nursing of the patient, and getting the bed-sores to heal) is consequently increased.

Of fractures between the fourth dorsal and third cervical vertebræ. It is a melancholy fact, that, in general, when the spinal cord is destroyed in the upper dorsal, and the cervical regions, the main question is, merely, how many days is the patient likely to survive the fatal injury? In such cases, the principal cause of mortality is the greater or less interruption to the operation of breathing.

When the cord retains its functions to the level of the fourth dorsal vertebra, although deprived of the power of expanding about two-thirds of the lower part of the thorax in inspiration, and incapable of contracting the abdominal muscles in expiration, yet the patient possesses the power of elevating and dilating the superior third of the chest, in combination with the action of the diaphragm, for drawing air into the lungs; and the recoil of the parts, by the elasticity of the structures generally, compensates for the paralysis of the abdominal muscles, and enables him to expel it again. Accordingly, respiration can be carried on with a considerable degree of power.

But if the fracture be above that point, say at the part where the cervical join on to the dorsal vertebræ (the cervico-dorsal portion, formerly noted as peculiarly liable to be broken), the whole series of intercostal muscles, as well as the abdominal parietes, will be paralysed. To explain how the process of respiration, in that defective condition of the organ, can be continued, it has been thought sufficient by writers to affirm, without discussion, that it was effected by the action of the diaphragm exclusively. As, it was said, the phrenic nerve, which controls that muscle, comes out from the spine above the fourth cervical vertebra, remotely from the injury, it will retain its function: when the diaphragm, therefore, contracts, the act of inspiration will be performed; when it relaxes, the weight and elasticity of the abdominal viscera and parietes will cause it to recede into the thorax, and expiration will follow. But that explanation is not perfect. It is complete in reference to cases in which fracture may have taken place at the fourth cervical vertebra, and the phrenic is the only nerve which descends from the neck to the thorax, above that point. But it ought not to be forgotten, that, from below the fourth and next lower vertebra, a nerve passes out from the spine, the function of which appears to be to associate the serratus magnus anticus, on the outside of the chest, with the diaphragm, in the act of inspiration. The nerve referred to is the external thoracic; which emerges from the intervertebral foramina between the fourth and fifth, and fifth and sixth cervical vertebræ; descends behind the axillary plexus, and is distributed on the serratus. That muscle has an extensive origin from the whole base of the scapula, and is inserted by digitations into the eight superior ribs; accordingly, when the shoulders are elevated and fixed, it must act with decided effect in lifting up and in expanding the whole upper portion of the chest. And as a certain tendency exists in the diaphragm, owing to its attachments to the ribs, when it contracts powerfully, to depress and draw together the lower margins of the thorax, that counteracting operation of the serratus must exercise an important influence in making the act of inspiration perfect. It may, therefore, be concluded that, in fractures of the vertebræ of the neck, if the spinal cord retain its function as low as the sixth, the diaphragm will have the coöperation of the serratus magnus anticus on each side. And that assistance will be valuable for expiration, as well as inspiration; for in proportion as the thorax is more elevated, it will descend with greater force by the elasticity of its structure, in expiration, and so expel the air from the lungs more effectually.*

Very frail, however, is the tenure, as already remarked, by which a patient, who has suffered fracture of the cervical vertebræ, holds life. The causes which commonly cut him off early, are twofold. 1st. Owing to the paralysis of the abdominal muscles, and the absence of that compression on the hollow viscera which they naturally exercise, gases are evolved and tympanitis speedily supervenes. When that takes place, the diaphragm is pushed upwards and makes violent efforts to overcome the pressure of the distended bowels; being opposed in its descent, the fibres attached to the ribs along the margin of the chest act from the cordiform tendon as a fixed point, draw their extremities centrically, and cause a groove or constriction to be formed in the line of the junction of the ribs with the cartilages. Respiration is thus performed generally with great labour; and the act of expiration is especially difficult. 2dly. The mucus naturally secreted in the air-passages is liable to lodge and accumulate, owing to the inability of the patient to expel it by coughing. If he should have suffered, previously to the accident, from chronic bronchitis, even of a slight kind, his condition will be so much the worse; for he will not be able to relieve himself of the sputa by expectoration; the mucus will become more tenacious, and clog the bronchi in such a manner that the air will not get access to the blood; imperfectly oxygenated blood will circulate through his brain; and death will be ushered in by low delirium and coma.

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* See *On the Nervous System*, by Sir Charles Bell, third edition, p. 97. Also, a paper, by the writer, "On Deformity of the Chest from Dyspnœa," *London Medical Gazette*, 1841.

Although it has just been said, that the duration of a patient's life who has had fracture of one of the inferior cervical vertebræ is commonly so short that the number of his days may be counted by units, yet extraordinary instances of persons surviving, not only for months but years, are occasionally met with. Of such cases, one of the most remarkable on record is that detailed by Mr. Hilton, in his recent course of Lectures on Surgery at the Royal College of Surgeons. The patient, when twenty-one years of age, fell a height of forty feet from a tree, and fractured the bones of his neck. The arms and legs, together with the bladder and rectum, were completely paralysed; and they continued so till his death. He lived for fourteen years; and he came to his end by another accident; having been upset, on a hard road, while being drawn in a low cart by a boy. For the notes of another, unpublished, case, to be considered even more extraordinary than the preceding one, seeing that it was the fifth cervical vertebra which had been broken, the writer is indebted to the kindness of Mr. Page of Carlisle, by whom the patient was attended.

"A gentleman, twenty-six years of age, the heir to extensive landed property in the south of Scotland, while in the act of running on the edge of a terrace adjoining his father's mansion, accidentally fell upon a hard road beneath, a height of ten or twelve feet, and injured his neck. From that moment every part of the body, with the exception of the head, was completely paralysed, the power of rotating the head being all that remained to him. In that state, without the slightest variety as to the extent of the paralysis, he continued up to the time of his death; which took place nearly fifteen months after the accident. At the post-mortem examination, it was found that the spinal column in the region of the neck had received a twist, which had caused some lateral displacement of the spines of the vertebræ; and this had given rise to the supposition that several of the bones had been implicated in the fracture. Such, however, was not the case; the fracture being limited to the fifth cervical vertebra; the body of which had been fractured horizontally, and a wedge-shaped portion broken off, which projected about a sixth of an inch into the canal. The whole bone, with the exception of that portion, was driven slightly forwards; consequently the size of the canal at this part was lessened, but not to such an extent as to compress the cord. Opposite the projecting wedge of bone, the cord was so nearly divided, that a portion only, of less size than a crow-quill, remained entire for a space of about three-eighths of an inch. Above and below this, the cord was reduced to a softened pulp; but beyond, it was firm and healthy. There could be no doubt but that the severance of the cord and the damage in the immediate neighbourhood of that point were inflicted at the moment of the accident."*

Of fractures of the vertebræ at the summit of the column. It is almost superfluous to state, that if the spinal cord be crushed, and have its functions destroyed, by fracture occurring at any point between the occiput and third cervical vertebra, under which the phrenic nerve issues from the canal, not only will voluntary motion and sensation in the whole body be lost, but the act of respiration will suddenly cease. Simultaneously with the arrest of the breathing, the heart, by sympathy, will stop; blood will not flow to the brain; and death will be instantaneous.

The accident which is most frequently the cause of that appalling mode of death, is fracture or dislocation of the atlas and axis. If a man be precipitated from a height and light upon his head, the impetus of his weight will be conveyed along his spine, and be concentrated at the junction of the column with the base of the skull. The part of the skull also intermediate between the point where the head impinged on the ground and the joint will act with lever power, when the head rolls, to increase the effect of the force. Accordingly, a violent shock and strain will be directed on the atlas and axis. The effects produced vary somewhat. Perhaps the most common event is, fracture of the processus dentatus of the axis, at its root, with laceration of the ligamentous connexions between the two bones, and dislocation of the atlas forwards. At other times, the tooth-like process slips from the grasp of the transverse and restraining ligaments, and, freeing the atlas, allows it to slide forwards, with the head resting on it. Again, the transverse ligament may be ruptured, so as to liberate the processus dentatus, and lead to another form of dislocation of the atlas. Lastly, combined with any of the injuries now specified, there may be transverse fracture of the slender, posterior arch of the atlas. In all these forms of accident, it may have been observed, that the atlas, sustaining the head, is carried forwards in a horizontal direction upon the plane of the axis. It accordingly acts, not unlike a guillotine, in severing the spinal cord from behind, forwards. An operation identical in its effects to "pithing," as practised by the knacker, or the light-limbed matadore in the bull-fight, is performed, in these injuries, by the atlas. As stated before, death caused by such crushing of the highest part of the spinal cord is instantaneous. In the Museum at the Middlesex Hospital is preserved the axis of a man who had been shot, at the back of his head, as he lay on his side asleep. The pistol-bullet had passed, in the mesial line, horizontally between the arches of the atlas and axis, had cut through the spinal cord, and, as the preparation shows, embedded itself in the base of the odontoid process. His mistress, being awake, in describing the act, dwelt on the fact that, notwithstanding the loudness of the report, the murdered man was not startled, never moved a limb, but seemed to continue his sleep undisturbed.

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* Dr. Smith of Moffat, with Dr. James Duncan and Mr. Syme of Edinburgh, also attended the patient. Dr. Duncan, who conducted the post-mortem examination with Mr. Page, in a communication received while these pages were in the press, states that the fourth cervical vertebra was the one fractured.

In the same Museum, there is a specimen of fractured and dislocated atlas and axis united, which claims notice in this place. The lesson taught by it is, that even when the vertebra in immediate relation to that vitally important part of the nervous centre has been exposed to injury apparently of the most formidable kind, the cord may, nevertheless, elude the danger. The vertebræ were removed by Mr. B. Phillips, from the body of a man, whom he had attended from the time of the accident till his death. The patient was a farm-labourer, who had fallen head-foremost from a hay-rick. He was stunned, but shortly recovered, and walked for medical aid. He suffered so little inconvenience, that in two days he resumed his occupation. A month afterwards he walked two miles to Mr. Phillips's house, his chief complaint being that he had a stiff neck, and could not rotate his head. There appeared to be enlargement of the tonsils; he had thickness of speech, and some difficulty of deglutition. He lived for a twelvemonth after the accident, his death having been caused by general dropsy. The specimen shows, first, that the atlas had been broken transversely at the thin part of its posterior arch, behind the articular processes; and that the odontoid process of the axis had been broken at its base. It next shows that the front part of the atlas, including the articular processes (the whole bone, except the small portion of the posterior arch broken off behind), had been torn from its articulations with the occiput above and axis below; that it had been then jerked forwards and downwards in advance of the body of the axis, so as to be thrust against the pharynx; and that when it had been thus dislocated, the condyloid processes of the occiput settled down upon the articular surfaces of the axis, formerly occupied by the atlas, and formed a new joint. Finally, it shows the anterior three-fourths of the circle of the atlas, united at each of its limbs, by dense ossific matter, to the front of the axis; so that a ring, resembling the hole for the cord, appears situated on the fore part of that bone. Accordingly, the axis, with the large portion of atlas adhering, presents the singular appearance of a vertebra furnished with two foramina, or spinal canals, on the same horizontal plane, the one true, and the other false; and two sets of articular surfaces, one in front of the other, both in the upper and under aspects of the bone.

To account for the spinal cord having escaped injury, it can only be supposed that, after the atlas had been broken transversely, and the odontoid process of the axis had given way at its base, the front and principal part of the atlas had been projected, by the compression of the occiput and axis, from the fore part of the theca vertebralis (which at this part is thick and tough); and that, as the occiput subsided upon the articular surfaces of the axis, the change of relation took place without any serious bend or shock to the spinal cord.*

OF BED-SORES, CONSEQUENT ON PARAPLEGIA, FROM FRACTURE OF THE SPINE.

When a man has had the spinal cord crushed or torn, from fracture of the spine, so low down in the column that respiration has not been materially affected, it is not the loss in the parts below of voluntary motion and sensation which directly destroys, or even tends very decidedly to shorten, life. Cases of persons living for many years with paraplegia are not uncommon. The fracture itself cannot be said to carry off the sufferers. If the circumstances be favourable, the vertebræ will unite. Inflammation may, perhaps, spread from the seat of injury to the cord and its membranes, and be the direct cause of death; yet that is a comparatively rare termination of such cases. The two most formidable agents in destroying patients who have sustained fracture of the spine are, first, bed-sores on the hips; secondly, disease of the urinary organs. These unite their influences, and together exhaust the strength of the patient.

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* For Mr. Phillips's account of the case, see the *Medico-Chirurgical Transactions*, vol. xx. p. 78. That gentleman afterwards made a present of the specimen to Sir Charles Bell.

Of the formation of sloughs and bed-sores. It does not appear to be of moment at what part of the spine the cord has been deprived of its functions, for determining the formation of sloughs on the back. A greater difference may be more reasonably looked for, according to the bulk of the patient, the strength of his constitution, or his age.

The part on which the skin almost invariably gives way first, in these cases, is the convexity of the sacrum. After that, may be taken the skin over the tuberosities of the ischia; then over the trochanters of the thigh-bones.

The period at which the sloughs begin to manifest themselves differs in various persons. It has been alleged that they have been formed so early as the second day after the accident. They appear, in general, for the first time, about the fourth day.

The earliest indication of a slough being about to form is a pale, mottled, flaccid, and perhaps sodden, aspect of a patch of skin upon the prominent bone. The surface then breaks, with an abraded appearance of the cuticle, and distils slight moisture. Lastly, a portion becomes positively black; and a gutter, or line of demarcation, begins to surround the mortified part. Yet the process of sloughing will ere long transgress that line, which will be included in a patch of still larger dimensions. The end of such sloughs is, that, when the skin has been disintegrated, has given forth foul discharge, been detached spontaneously, or clipped away, the bone beneath becomes exposed, and is at length necrosed. When the sacrum has been thus injured, the vertebral canal has been opened; and, in some cases, inflammation has spread with fatal effect to the membranes of the cord. In other cases, the sloughing has gone so deeply as even to involve some of the muscular structure of the nates.

In reference to these sores, one of their most remarkable features is the rapidity with which they form and extend, and that in persons not debilitated by previous illness, but shortly before in robust health. That observation has gone far to induce a very general belief that the chief cause of the production of sloughs, in cases of paraplegia from fracture of the spine, was a supposed defect of nervous force in the parts, due to the destruction of the spinal cord. But, before receiving that explanation with entire confidence, let the peculiar circumstances in the condition of a patient suffering from the effects of a fracture of the spine be well considered. When a man has had his back broken, nothing, in a living body, can equal the permanent fixedness of his hips and legs in the exact position in which they had been originally placed when he was first put upon his bed. Three distinct causes contribute to produce that absolute immobility. The first and most obvious one is the want of command over the muscles of the paralysed parts. The second is, that, from being deprived of sensation, the patient is unconscious of irksomeness or pain from always retaining the same position : he, therefore, does not desire any change, or ask his attendants to shift his posture. Thirdly, the fracture of the spine itself is a cause of his inability to move : he may possess sufficient strength in his arms by which to lift or turn himself ; but as the beam that connects the upper with the lower part of his frame has been broken, his efforts will be abortive ; and if his nurse attempt to help him, the pain and additional injury to the part will make them desist. Accordingly, the man continues lying, quite indifferent to, or ignorant of, the bad consequences, in one settled position all day, and all night, perhaps for several days consecutively. Hence, the whole weight of his hips will press with concentrated force on the integument which covers the most projecting points of his pelvis. The skin overlying the superficial, convex, and irregular surface of the sacrum receives the principal pressure. That compression interrupts the circulation : the blood which ought to go to the part is prevented ; that which ought to be in, is squeezed out ; and the vessels are tenantless. An additional evil remains to be mentioned : with the greatest care, it is almost impossible to prevent a small quantity of urine, at least, from trickling down into the bed-clothes ; besides that, liquid fæces, in spite of every attention to cleanliness, lodge about the anus, and are mixed with the urine ; the skin of the patient's nates becomes sodden, macerated, in that noisome mess, the acrid fluid acting upon his tissues like a caustic. It is not surprising that, from the combination of steady, uninterrupted, inelastic, dead pressure of the skin against the sacrum, with the irritating influence of the wet bed-clothes, the portion should become, even in a short time, dead, and be converted into a slough. Light is thrown on the causes which produce these sores, by noticing how different are the effects when, under favourable circumstances, the patient has overcome the first dangers, and the fractured spine has become united. As soon as the consolidation of the column takes place, although there be no amendment whatever in regard to motor power or sensation, it may be expected that the sloughs will separate, and that the sores will fill up with granulations, and cicatrise. Now that improvement is to be ascribed mainly to the union of the fracture; and to the opportunity thereby afforded of turning the patient's body frequently, and performing the various offices of nursing more effectively than before. The same thing is witnessed in persons affected with paraplegia, from tumours within the vertebral canal, or caries of the spine, when anchylosis has taken place; by moderate attention to nursing, sloughs or bed-sores may be easily averted, or healed up, if already formed.*

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* To affirm that sensation, or pain, is provided as a safeguard to the textures of the body, is a physiological truism. It is equally familiarly known that the degree of sensation differs according to the wants of the particular structures. If an organ be little exposed to outward danger, its sensibility will be obtuse; if peculiarly liable, from the delicacy of its textures, to rapid destruction, the sensibility will be proportionately acute. Of all parts of the frame, the eye is at once the most open to external injury, and the organ whose tissues are most prone to be disorganised from slight causes. For these reasons, its surface is endowed with a sensibility unparalleled for acuteness; and the efficiency of the sense in defending the organ against inflammation, is an universal theme of admiration.

After it had been ascertained by Sir Charles Bell that the fifth nerve of the brain conferred upon the eye that exquisite sensibility, it occurred to M. Magendie to endeavour to advance the subject a step further. He instituted a series of experiments, often quoted, for the object of proving that, besides giving sensation as a guardian to the structures, the said nerve presided over the very organic processes subject to be deranged; that the fifth possessed the distinct power of superintending the actions of nutrition in the eye.

That view, important in itself, has an interest connected with our subject; for it has been assumed that the nerves of sensation of the spinal series, analogous to the fifth, possess a control over the organic processes of nutrition, in the structures which they supply, of a corresponding kind. Those who espouse that opinion apply it to explain the formation of sloughs on the nates, in cases of fracture of the spine. They allege that the disorganisation of the integument is simply the consequence of the nerves of sensation being bereft of their power of maintaining the actions of nutrition.

The experiments which M. Magendie instituted were performed upon rabbits and such-like animals, and his observations did not extend to man. He divided the ophthalmic branches of the fifth, and having thereby duly

Of disease induced in the urinary organs. The debilitating effects of formidable bed-sores on many points of the hips at the same time, may be readily estimated. But simultaneously with these the patient has to undergo other serious processes of exhaustion, arising from morbid changes in the urinary organs. Owing to the bladder being deprived in its internal coat of sensation, and the muscular coat being unable to expel its contents, disease extends to the whole series of parts, including the kidneys.

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deprived the eyeballs of the acute sensibility appropriate to them, he waited the results. After the lapse of a certain time, the eyes of the animals were examined, and it was observed that they quickly underwent destruction, with sloughing of the corneæ. These were the grounds on which he concluded that the fifth had control over the nutritive actions of the eye.

In the narrative of the experiments, it is not stated whether the operator, after he had deprived the rabbits, by totally abolishing sensation in their eyes, of their natural safeguard against violence, had employed any means for averting injury. In the absence of information, we may assume that the animals were returned to their dark cages; and, if such were the case, it cannot be doubted that their eyes would be penetrated, without their consciousness, by the sharp ends of straw; that dust would be lodged plentifully between their eyelids; and that the conjunctiva would be irritated and inflamed by the pungent effluvia of their own excrements.

The writer has had the opportunity of carefully watching, during many months, several well-marked cases, in man, of destruction from disease of the fifth, at its roots,—cases in which the whole functions of the nerve had been as thoroughly lost as could have been effected by the infallible bistoury of the experimentalist. In these cases it was unquestionable, from the total abolition of sensation in the eye, that the ophthalmic branches, in common with the rest, had been involved in the morbid growth. Now it was observed in all, without exception, that so long as the eyelids, through the action of the orbicularis oculi, retained the power of closing and protecting the eye, its coats and humours preserved their transparency and brightness perfectly, and that there was not the slightest indication of disease, or weakness of nutrition. In most of the cases ptosis, from affection of the third nerve, accompanied the disease of the fifth; hence, besides inability to move the eyeball (except outwardly), there was constant dropping of the upper lid, and that closed condition of the eye kept it permanently safe. Although here were two nerves, each of which sent branches into the ball of the eye, deprived of their functions, neither the conjunctiva, cornea, sclerotic, iris, nor any other tunic, manifested unsoundness. A notable occurrence, illustrative of the subject, took place in one particular case. It was one of the cases in which the third nerve had been affected conjointly with the fifth, and in which the upper lid had fallen over the face of the eye, being kept down, as usual, by the action of the orbicularis oculi. The eye itself, as in the others, had remained perfectly transparent and free from inflammation during many months. But eventually the tumour at the base of the skull, which had obviously been confined before to the proximity of the fifth and third nerves, enlarged, and included within its embrace the portio dura. The result was, that, in common with the facial muscles generally, the

1. The bladder becomes inflamed from over-distension. The patient being no longer prompted by calls to pass his water, and the detrusor urinæ having lost its power of expulsion, there is constant danger of the urine accumulating, and filling the bladder beyond its normal capacity. That risk is met by the Surgeon drawing off the water at regular intervals. But, owing to the quantity of urine secreted varying at different times, and other causes, that mode of relief is an imperfect substitute for the natural one; and the walls become occasionally over-distended. Now, the effect of over-distension is, an excessive stretching, and consequent tearing, of the tissues of which the coats are composed; and it is reasonable to suppose that from that cause inflammation should arise. When the viscus is similarly expanded beyond its ordinary dimensions, in retention of urine from enlarged prostate, we constantly find that,

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orbicularis oculi became paralysed. Hence both the muscle which elevated the eyelid (levator palpebræ) and that which shut it (orbicularis oculi) were simultaneously paralysed, and the lid, being thus perfectly passive, kept at any part where it was put. Accordingly, the eye ceased to be properly covered by the superior lid, and it was observed that contemporaneously with that change the eye began to inflame; the conjunctiva became intensely red and tumid; and vision was soon lost, from opacity of the cornea. In this case it would have been illogical to have concluded that the portio dura had the power of regulating the nutritive processes of the eyeball. Yet the destruction of the tissues followed the loss of function by that nerve, quite as directly as it could have done, in any of the rabbits, the division of the fifth.

All that can be said on the question, it appears, is simply this. For the protection of that extremely delicate organ, the eye, certain provisions have been made. An acute sensibility on the surface is one of these; a mechanism of eyelids and fountain of tears is another. If either the nerve which bestows sensibility, or that which animates the muscles of the lacrymal apparatus, be deprived of its function, the organ is abandoned to the destroying influences against which they were designed to defend it. Accordingly, the nerves of sensation and motion referred to may be correctly said to exercise an indirect control over nutrition. But the proper nerves which directly superintend the organic processes, support the structures in their integrity, or guide them through disease, do not belong to the cerebro-spinal system. They consist of the innumerable fine nervous filaments which, coming off primarily from the large ganglions of the sympathetic system, entwine themselves in plexuses about the blood-vessels, and accompany them to their minutest ramifications. In the normal condition of the body, these sympathetic nerves are fully well qualified to control the nutritive actions. But if the eye be rudely bereft of its sensibility by an experimentalist, or if, from fracture of the spine, the lower extremities of a man have lost both motor and sensory power, a state of the structures is implied inconsistent with the natural actions of the economy, and the parts succumb to disease.

although there had been no previous signs of inflammation, the mucous and other coats become rapidly and dangerously inflamed. 2. The frequent repetition of the introduction of the catheter, imperatively called for, is another cause of inflammation being excited. In consequence of the patient's insensibility, he gives no token, even when the instrument is used rudely, of being hurt; and the Surgeon is apt to be betrayed into carelessness. But, whether the operation be performed gently or not, there is reason to believe that the repeated passage of the catheter brings on inflammation in the urethra and neck of the bladder.* 3. Within a few days, varying from the second to the ninth, after the accident, it is commonly observed that the urine, previously acid and clear, becomes alkaline and turbid; and the change is made known by the pungent ammoniacal smell. The turbid appearance is due to the addition of mucus; that increases gradually, sometimes to a large amount; and it becomes tenacious and ropy, so as to adhere to the bottom of the utensil. After a time, white matter, ascertained to be phosphate of lime, is found in the mucus. Blood is also sometimes combined with the other contents. That disordered condition of the urine generally lasts, in fatal cases, till the death of the patient. But not unfrequently its duration is temporary, and there is an alternation of periods when the urine is either acid or alkaline. Cases are also met with, in which the prevalent condition throughout has been that of acidity.

In explanation of the differences in these respects, it has been alleged that the urine, on first entering the bladder, is on all occasions acid; and that the change to alkalescence takes place during its stay in the viscus. The theory proposed is to this effect: when the coats have lost sensation and motor power, it is supposed that they are deprived at the same time of the peculiar influence by which, as living textures, they are capable of having with impunity a foreign or excrementitious fluid, compound and acrid in its nature, in contact with them. Between all the hollow viscera and their contents, a mutual relation of that kind exists; as the stomach with the gastric juice, the gall-bladder with the bile, the rectum with the fæces. If the relation be broken, for example, in the case of the bladder, and if the urine be extravasated into the cellular membrane, or the cavity of the peritonæum, disastrous effects, sloughing or acute inflammation, will be produced; if the urine be voided, and kept in an utensil, chemical changes, previously restrained, will take place. It is conceived that in paraplegia the influence adverted to is no longer possessed by the mucous coat; and it is further supposed that the affinities which bind the various constituents of the salts of the urine together are deprived of their natural attraction. Hence it is concluded, that the urea becomes separated into its original elements; that the disengagement of ammonia (thus accounted for) explains the ammoniacal odour; and that new combinations, leading to the formation of phosphatic salts, take place from the other elements let loose. Processes of change of a chemical nature, such as these, cannot, it is said, be carried on within the bladder, without exciting irritation in its coats. Accordingly, inflammation falls on the mucous membrane, and extends to the walls generally. A superabundant secretion of mucus, of a tenacious, birdlime consistence, is the consequence; and the morbid action proceeds along the ureters, till the kidneys are included. The inflammation is of such violence, in some cases, that portions of the mucous membrane are thrown off, with indescribably fœtid odour, as sloughs. In other chronic cases, again, calculi of phosphate of lime form both in the bladder and in the kidneys; and these set up fatal irritation in the organs generally. A young man, under the writer's care, in the Middlesex Hospital, from falling off a tree, had fracture of one of the dorsal vertebræ, and complete paraplegia. He passed with difficulty through the dangers of sloughs on his nates, and disease in the bladder; and after surviving for eight months, appeared about to recover, with paralysis remaining. During the principal part of that period the urine flowed continuously into an urinal, and the catheter was not used. Nothing untoward was observed, and suspicions were not awakened. Eventually, the urine became turbid and fœtid: and the patient died with symptoms of sloughing of the interior of the bladder. On the post-mortem examination, five phosphatic calculi, each about the size of a pigeon's egg, but of irregular, angular shape, were found lying together in the lower fundus of the bladder, surrounded by foul thick mucus, and with the internal coat discoloured and shreddy. Calculi of the same nature were impacted in the calices, and contained loosely in the pelvis, of both kidneys. In this case, owing to the insensibility of the bladder, pain, which is generally the most prominent symptom of stone in the bladder, had been entirely absent: again, owing to the patient's being confined to bed, and the detrusor urinæ having ceased to contract, the calculi were not subjected to a rolling motion; they did not acquire, therefore, the smooth, rounded form, characteristic of urinary calculi. The inflammation which supervened at last, it may be conjectured, was occasioned by the stones having gradually become so large, that they reached above the level of the orifice of the bladder, blocked it up, and so obstructed the flow of urine.

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* The writer has read and heard of more than one case of false passages produced. The swollen condition of the penis, called priapism, has been attributed to the irritation excited by the introduction of the catheter. But it occurs immediately, and before an instrument has been used.

In another patient, the writer observed a remarkable peculiarity in the shape of the bladder; which was obviously the consequence of the continual dribbling of the urine, common in these cases. The patient had complete paraplegia from fracture in the dorsal region, and his water had flowed continuously, for several months before death, into an urinal. In the post-mortem examination, the bladder was found of the usual form and capacity, at the lower fundus; but the body, together with the upper fundus, was in a state of close and permanent contraction; so that the cavity was completely obliterated, and that important portion of the bladder was thus apparently an useless appendage. To overcome the contraction, some force, and a boring action of the finger, were required. It was obvious that, from the urine escaping through the urethra, about as quickly as it entered the bladder by the ureters, the cavity above the level of these orifices could not be kept expanded; the walls, therefore, closed and remained contracted.*

Prognosis in Cases of Paraplegia from Fracture of the Spine.

If a man, after a fall, be reported to have "broken his back," it is known generally to be one of the gravest accidents. The first thing which will determine our opinion as to the probability of the patient's surviving the effects, even with paralysis, is the age. Owing to the great elasticity of the spine in early life, fracture of the vertebræ is not an accident of boyhood. Seldom is it met with till the beginning of adolescence. When it occurs then, there is a better chance than later of the patient's living. If the column be broken in a person of middle age, or beyond that period, scarcely any hope can be given of his overcoming all the dangers and escaping with life. The next question of importance is, the situation of the fracture. If the injury be below the level of the second lumbar vertebra, where the cauda equina is contained, it may be expected, even when the displacement is great, that the patient will retain motor and sensory power (with, perhaps, some partial impairment) in his lower extremities, and be exempt from paralysis of the bladder or rectum; and that in eight or ten weeks he will recover, with slight deformity and stiffness in the loins. Should the fracture be a short way above the part just spoken of, in either of the vertebræ which embraces the terminal portion of the cord surrounded by the roots of the nerves, the paralysis may be partial; or, if complete, the patient will enjoy some hope of recovery, with restoration, more or less considerable, of motion and sensation in his lower extremities. When fracture occurs in the dorsal region, the prognosis is, in every case, unfavourable. The paralysis, it may be said, is always complete. But when the fracture is situated below the level of the fourth vertebra, recovery is not so hopeless as when above; the difference depending, as explained above, on the extent to which the intercostal muscles and diaphragm have been paralysed, and the function of respiration interrupted. In fracture of one of the vertebræ of the neck, or divulsion of two, with or without complete or partial dislocation, the cord is generally crushed so thoroughly, and the paralysis is so general over the body, that, as remarked before, instead of entertaining the question of the patient's recovery, the Surgeon counts by days only how long he may probably live. The sole chance that he clings to with any hope is, that the spinal cord may have been so slightly injured, as to have produced only transient paralysis. If the fracture has been at the summit of the spine, in the atlas, or processus dentatus of the axis, unless the patient should escape in the wonderful manner related in Mr. B. Phillips's case, he will be dead before the Surgeon can reach him.

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* A principal obstacle to success in operations for vesico-vaginal fistula is the contracted condition of the bladder, consequent on the continued dribbling of the urine.

Cases of recovery from fracture of dorsal vertebræ. The two following cases are inserted in this place, as they will be found to illustrate several subjects discussed in the preceding pages. The first is that of a patient who recovered (with paralysis remaining) from fracture in the dorsal region, and who was seen by the writer, in perfect health otherwise, more than twelve years after the accident.

Mr. R., thirty-two years of age, from the West of England, consulted the writer in the summer of 1860. When about nineteen years old, he fell, with a branch of a pear-tree on which he sat astride, a height of thirty feet. He was found to have fracture of the spine, between the eighth and tenth dorsal vertebræ, and complete paralysis of the lower extremities and of the bladder and rectum. In the early period succeeding the injury, his life was despaired of during several weeks, on account of immense sloughs on his nates and the disordered condition of the urinary organs. At length the sores healed; and for promoting that end he attached great value to the use of india-rubber water-pillows, which he began to use a fortnight after the accident. These pillows he has occasionally tried to give up; but as soon as he relinquished them, new sores quickly formed, and he employs them to the present time, whether sitting or lying. The urine was drawn off by the catheter twice daily for three months. At first, it was extremely offensive, and loaded with ropy mucus. Subsequently, the water began to dribble away, and the introduction of the instrument was discontinued. Though there is still incontinence of urine, the bladder, which appears a capacious one, becomes filled. He is made aware that it is distended by what he describes as a peculiar tremor felt at the pit of the stomach. He then, with both hands, squeezes the abdomen in the region of the bladder, and so causes an increased quantity of urine to be expelled. The above proceeding he repeats about every third or sixth hour. During the first year he was subject to distressing inconvenience from either the constant or frequently recurring involuntary discharge of the fæces. Since that time, there has been the same want of control over the passage of the stools; but the act has been performed at very distant intervals, the ordinary period between them being seven or nine days. Sometimes the interval is a fortnight. A short time before each action of the bowels he experiences a sense of heaviness in the head, and has slight flushing of the face; and the stool which comes is immensely large and of nearly solid consistence. It was not till six months after the accident that his hips were sufficiently sound for him to sit up and be wheeled in an invalid-chair. The legs are now entirely devoid of sensation; and during the first eighteen months they were perfectly motionless. After that the effects of galvanism were tried, and ever since both limbs equally have been subject to sudden, and sometimes violent, startings. These are commonly excited by touching, or changing the posture of the legs; but they take place when he is lying quiet, without any apparent cause. Within the last six years the strength and frequency of the convulsive actions have abated, and they have never caused pain; but, as they are both inconvenient and disturb his sleep, he is accustomed to fasten his feet by straps to the sides of the bed, by which they are counteracted. Since recovering from the dangers immediately following the accident, his health has been almost uninterruptedly good. His lower limbs, from the hips downwards, are atrophied, and the joints of the ankle, instep, and toes, stiff and distorted. But in the upper part of his body he is stout and powerfully built, the muscles of the shoulders and arms being developed to a size seldom seen, even in the most athletic. He drives himself in his open carriage. He was not fatigued from his long railway journey. During his short stay in town he paid visits to the Crystal Palace, and other places of interest. He is provided with a mechanical bed, combining all the ingenious contrivances of its most improved form.

The next is the case of a man who had fracture and paralysis in his youth; who shortly afterwards recovered sensation and the power of motion in his limbs, so as to be able to follow an active occupation; who, after a period of seventeen years, had a return of the paraplegia, and, lingering for five years in that condition, died under the observation of the writer, who had the opportunity of examining the body.

H. P., aged forty-four, a shoemaker, was admitted, under the care of the writer, into the Middlesex Hospital, 17th May 1849, for paraplegia and extensive bed-sores. He related the history of his case with intelligence; and it extended over a period of twenty-one years. At that date, he fell from the second-floor window of a house in Edinburgh, and was carried insensible to the infirmary. He recovered consciousness on the following day; and finding himself unable to move his legs, and deprived of sensation in them, he was informed that, in his fall, he had fractured his spine. The pain in his back was near the centre, between the shoulder-blades, at a part corresponding to the fifth or sixth dorsal vertebra, where an irregular projection, of a very slight kind, could be perceived. Being unable to pass water, a surgeon attempted to draw it off; but as the bladder contained clots of blood, he did not succeed till he had injected warm water through the instrument. Afterwards, the bladder was emptied by the catheter at regular periods every day. In two months, the power over the limbs, and that of voiding the urine, began to return; and about the fourth month, being then able to walk, he was discharged from the infirmary; having previously had an issue made on each side of the spine, at the seat of injury. The sense of feeling in a part of the right leg remained defective; but he gradually became stronger in his gait, and returned to his occupation. There was now an interval of seven years, during which he was in sound health, and led an active life. He then had a fever; ascribed to a cold caught on the top of a diligence, while travelling in France. A year afterwards, he consulted the Surgeon who had attended him on the occasion of the accident, for a pain situated in the part of the spine which had been fractured; and, on his advice.

he kept an issue open at the place for several months. His health was then reëstablished, and he followed his pursuits as usual for five years. At the end of that period, thirteen years from the date of the fall from the window, he began to feel weak in his limbs, and to drag them heavily. For a term of five years, that weakness went on gradually increasing; so that, at first, he could walk with a single stick, afterwards he required two, then he used crutches, and at length he was obliged to keep his bed. Having been bed-ridden, on account of total loss of power and sensation in the lower extremities, for two additional years, he became paralysed in his bladder and rectum; and from that time he began to have extensive sores on his hips. During the whole progress of the paralysis, the lower extremities were affected with frequent convulsive startings, brought on without any perceptible cause. Six months before his coming to the hospital, both legs became contracted at the knee-joints, and drawn up closely to the abdomen; and they have continued fixed in that position ever since.

Condition upon admission. At the seat of the original injury, and in the whole course of the spine, there was total absence of pain, as tested by pressure. From below the umbilicus, the paralysis of all the parts was complete; the skin was insensible; the legs rigidly contracted and motionless; the urine dribbled incessantly, and the fæces passed involuntarily. When pinched or pricked in any part, the doubled-up leg that was touched moved with a sudden jerk, and in the abdominal muscles a similar reflex motion was perceived. It was learned, on inquiry, that the motion of the limbs thus produced communicated an impulse to the superior part of the body; which led the patient to distinguish whether it was the right or left leg that had been pinched or pricked: hence there was a source of deception, which might have induced a careless person to suppose that some degree of sensation was retained in the limbs; but that it was entirely gone was satisfactorily proved by finding that, although he could tell which leg was irritated, he could not specify the spot. The bed-sores were of great depth and extent, and the surfaces foul and sloughy: the principal one was over the sacrum, a part of which, in the centre, was denuded and black; others of less size corresponded to the situation of the tuberosities of the ischium and the trochanters, on both sides.

By placing the patient, at first, on a water-bed, subsequently on a bed with a frame constructed of spiral springs; by careful nursing, improving his diet, giving quinine and opium, and dressing the sores principally with balsam of Peru, the deep ulcers gradually got clean; healthy granulations sprang up; and they all eventually skinned over and remained sound, except the one over the sacrum: the sore in that situation was retarded in healing by the denuded portion of bone; yet it cicatrised, all but a part of the size of half-a-crown. It was a remark of the dressers, that the patient gave no signs of pain when the granulations were touched with the lunar caustic. Another point of interest may be noticed; as his end approached, the patient several times had profuse perspiration; on these occasions it was observed that while the skin of the whole upper, sound part of his body was covered with drops of moisture, which thoroughly drenched his shirt and the hair of his head, the lower extremities were quite dry. His bowels were habitually costive; and when they had been long confined, he complained of oppression in his breathing. The bladder did not rise above the pubes; the urine was healthy, and free from any undue quantity of mucus. At the end of eight months from his admission he died, from general exhaustion.

Upon examining the body after death, the principal points of interest were, the state of the vertebræ at the seat of injury; and the morbid change in the spinal cord. The appearances of a fracture having formerly taken place, followed by union of the fragments, were distinctly visible in the fifth dorsal vertebra. The fracture, as traced from the front, had extended through the body, between its upper and middle third, and through the superior oblique processes and arch posteriorly; the whole upper fragment had then slipped forwards and downwards, in relation to the lower, causing a moderate, yet distinct bend, with a slight inclination to the left side, to be formed in the column. The surfaces were compactly united. The fourth vertebra was anchylosed, throughout all its inferior surface, to the corresponding upper surface of the fifth, by dense osseous structure; and the junction was so close, that both the space for the intervertebral substance, and the intervertebral foramina for the transmission of the spinal nerves, were obliterated, by the fusion. The fifth was not directly united to the sixth vertebra; but from the bodies of each outgrowths of bone had been thrown out, like buttresses, to give additional strength at the angle of fracture. Portions of two ribs, of the right side, were also anchylosed at the seat of injury. The vertebral canal partook of the angular encurvation caused by the fracture; but its natural capacity was not perceptibly diminished; and there was an absence of inequalities or asperities in the interior of its walls, such as might have set up irritation in the cord or its membranes: on the contrary, the posterior surfaces of the bodies of the fractured and adjoining vertebræ, with their interspaces, were lined by a dense polished layer of bone, upon which the theca must have rested with all safety.

In regard to the spinal cord, the first thing observed, on laying open the sheath at the part corresponding to the site of the fractured vertebra, was an apparent collapse or vacuity, in the place which ought to have been occupied by the cord. For two inches, the substance of the cord had disappeared; and in exchange for it there was a confused structure composed of arachnoid membrane and pia mater, converted into a loose cellular texture, not unlike that of the axilla, on its outside, but more firm and cord-like within. This fine fibrous and membranous tissue adhered lightly to the internal surface of the theca, which had not undergone any perceptible change, except that of being thrown into folds; and it connected the upper sound portion of the cord to the lower. Each end of these portions was soft and diffluent; but not distinguished by increased vascularity. It was difficult to ascertain positively whether there existed any continuous line of nervous substance in the meshes of the pia mater, intervening between the sound parts; all that could be seen was some amorphous granular matter, not recognisable as remains of the cord. It was distinctly observed that there was an absence of adventitious structures, the ordinary products of inflammation. The morbid change appeared to have been of the nature of "softening," or of a degeneration of the substance of the spinal cord, from fault of nutrition.

TREATMENT IN CASES OF FRACTURE OF THE SPINE.

Should the Surgeon happen to be at hand when the accident has just occurred, his first object ought to be to guard against motion of the spine, while transporting the patient to his home. Before allowing officious persons to lift him from the ground, provision ought to be made for his being borne on a door, shutter, or the like; otherwise there will be an aggravation of the crushing and tearing of the cord. If from the seat of pain it appear that the fracture is near the neck, a sack or pillow-case ought to be filled with sand; by heaping which about the head, it can be kept steady.

When the clothes have been *cut* off (to avoid motion), and it has been found that the fracture, or fracture and dislocation, is accompanied with considerable irregularity and projection of the processes, it is necessary to bring the parts into a more favourable position for future union. But the employment of much force is to be deprecated; a gentle stretching of the body, steadily continued, may be had recourse to; but, except in rare cases, a slight change of the posture of the patient is all that is needed; when laid flat on his back, the parts tend of themselves to come into correct apposition.

In selecting an appropriate bed some foresight is wanted. If an invalid-couch, on the principle of that of Earle, be procured, it will afford numerous facilities for nursing; by slightly bending its various joints, the trunk and limbs of the patient can be placed in a favourable position for steadying the spine at the seat of fracture: the direction of the pressure on the hips can be gradually changed from time to time; while conveniences for removing the evacuations without the necessity of lifting the patient from the bed are added. Should a bed of that kind be too expensive, the next to be preferred is a narrow one, rather low, with boards in place of sacking, and two or more elastic, yet firm, horse-hair mattresses. Mackintosh cloth, and over it a draw-sheet, should be placed under the patient's hips. Water-pillows, and common feather or horse-hair pillows, lined with oil-silk, should be bountifully provided. At first, and before the fracture has united, the water-bed of the full length of the patient is inadmissible, on account of its too great mobility.

Measures to avert inflammation at the seat of injury, particularly to guard against its invading the cord and its membranes, may, perhaps, be thought indispensable. Experience, however, shows that the application of leeches, or cupping, is not called for: that patients with paraplegia do not bear loss of blood; and that, instead of subjecting them to frequent motion in applying local remedies, it is best to preserve the spine in perfect repose.

One of the earliest duties to be performed is that of drawing off the urine, by the introduction of a full-sized catheter into the bladder. The patient may not have passed water for several preceding hours; he has no call to do so; and delay may be attended with injurious over-distension of the coats of the bladder. Hence, on receiving a summons to such a case, the Surgeon ought not to neglect carrying with him his box of catheters. Again, as the patient, however much the instrument may injure him, will give no token of pain, the operator ought to pass it with all gentleness. Twice in the twenty-four hours is commonly considered sufficiently often for the introduction of the catheter. But if the kidneys secrete abundantly, or if the urine become turbid and ammoniacal, a more frequent introduction may be expedient. In the latter case, the bladder ought to be washed out daily with tepid water, acidulated with nitric acid. Mineral acids may also be given internally. As incontinence of urine frequently goes along with retention, and the patient's linen is in danger of becoming wet, he ought to be furnished with an urinal; but due attention requires to be paid to that utensil, lest, owing to the insensibility of the parts, it be allowed to run over, or be upset. When the period arrives (if the patient should live) at which the neck of the bladder offers no resistance to the escape of the urine, and the latter continually runs off as water from an over-filled cask, watchfulness on the part of the attendants is more essentially required, to prevent the bedding from becoming soiled. The constant use of the catheter will be no longer called for; but it may be proper to introduce it occasionally, for removing, by injection, sediment collected in the inferior fundus of the bladder.

In the management of the bowels, it may be assumed that they will be, in general, costive. If the fracture be high in the column, so that the abdominal muscles are included in the paralysis, the absence of compression on the viscera favours the evolution of gases within the intestines, and tympanitis is the consequence. That distension by wind, coupled with loaded bowels, greatly aggravates the difficulty of breathing, caused by the loss of power in the intercostal muscles. When the sphincter ani relaxes, and abandons its opposition to the escape of the stools, the contents cease to be discharged at regular times, as during health: they pass out, without warning, at any unlooked-for moment; accordingly, however unremitting the nurse may be in her attention to cleanliness, her efforts will be defeated. But at a subsequent period, the stools are delayed in the great intestine; they become compact; they are discharged at long intervals; and the inconvenience resulting from their passing involuntarily is greatly abated. Medicines must be administered, with the view of correcting these various conditions, on general principles.

Treatment of sloughs and bed-sores. It has been stated above that the parts of the hips most liable to the formation of sloughs were those exposed both to greatest pressure and to continual irritation from lying on bed-clothes saturated with urine and liquid fæces: that it was the skin over the sacrum, and that over each of the tuberosities of the ischia, which gave way first. The obvious deduction from that observation is, that, in order to prevent the formation of sloughs, or to promote their cure, the chief objects are, first, to remove pressure; secondly, to insure cleanliness. Now the main obstacle to gaining these two ends, at the commencement of the treatment, is the injury committed on the fractured portion of the spine, by moving the patient's body; every time that is done, a jar is communicated to the broken surfaces; a grinding of one upon the other takes place; pain and inflammation are excited; and the process of union is interrupted. Yet, without frequently turning and lifting the patient, it is impracticable to ward off pressure, or keep the hips clean and dry.

It being imperatively required, therefore, that the position of the hips should be often changed, the attendants ought to be instructed how to accomplish the object with the least danger. Small pillows ought to be gently insinuated, at different times, under the hips. When compelled to turn the patient round on one side, care should be taken that the shoulders and upper part of the body are rotated, at the same time, in a corresponding degree.

As a means of protecting the skin from the chafing of the wet bed-clothes, much good might be expected from painting the surface repeatedly with collodion (to each ounce of which, twenty drops of castor-oil ought to be added, for the purpose of correcting its tendency to contract and crack); but as the application would require to be renewed about three times daily, and that would necessitate the patient's body being turned on each occasion, it can only be used partially at first; subsequently, if the fracture unite, it will be found of great service. Advantage may be gained by the ring-pillow—on a small scale, like the life-preserver on board a ship—being placed under the hips, so that the central hole may come opposite the sacrum, and the weight fall on the fleshy parts on each side. Or a plaster spread on thick material (as two layers of wash-leather, including between them a layer of felt, or amadou), with a hole cut out in the centre, may be stuck on the part which it is desired to defend. Lastly, the india-rubber water-pillow, of a size adapted to the hips, and containing a little air as well as water, may be used with advantage. For keeping the bed-clothes dry, frequent changing of the draw-sheet is the chief resource; but an additional measure may be resorted to: if the patient's thighs be kept apart, and the knees slightly elevated on a pillow, a large porous sponge, or some tow, previously wetted and wrung, wrapped loosely round with gutta-percha, may be inserted deeply in the perinæum; the excretions will thereby be caught, and be readily removed. If, notwithstanding every care, a portion of the skin lose its vitality, and the cuticle begin to peel off, the amount of destruction may be limited by dressing with the linimentum terebinthinæ. When the part is more decidedly mortified, with foul discharge, cotton-wool saturated with balsam of Peru is the best application; and over that should be laid either a firm, thick linseed poultice, or a compress of cotton-wool, moistened with yeast. The cotton-wool has the property when wet of clinging to the skin, and so prevents the under-dressing from being shifted. As the slough loosens, it ought to be clipped away with scissors. Should the surface happily become clean, and healthy granulations spring up, water-dressing, with a continuance of the measures for protecting the hips, will complete the cicatrisation.*

On trephining the spine. Here the question, often mooted, and still, it would appear, undecided, overtakes us: is it possible, by an operation on the spine similar to what is performed on the skull, to restore the lost functions of the cord? When a portion of the cranium has been driven in upon the brain, or a clot of blood from the meningeal artery has compressed it, paralysis of part of the body ensues; the Surgeon applies the trephine, elevates the depressed fragment, or removes the clot, and (in a successful case) the patient recovers. Upon such an analogy it has been proposed, and Surgeons at various times have carried the proposal into effect, to make an incision along the back (it was eight inches in length in one case), and with the trephine, bone-scissors, lever, and forceps, to extract depressed fragments of vertebræ from the posterior surface of the spine. By that proceeding, it has been thought that the spinal cord, having been relieved from compression, would regain motor and sensory power; and that the patient's life would not be jeopardised more than from the corresponding operation on the skull.

The objections urged against this formidable treatment far surpass in weight arguments or testimony brought in its favour. It might have been thought that one point alone would have sufficed to show its uselessness. When the column has been fractured, and portions of the vertebræ project against the cord, it is an error to imagine that the compression thereby produced is the sole or principal injury inflicted on the medulla. It cannot be doubted that, at the moment of breakage, the spine had been bent upon itself, and the cord along with it, much more extensively than is represented afterwards: the elasticity of its structure has enabled the column to recover its form in a great degree; accordingly, we are justified in concluding that the fragment compressing the cord must, at the time of the fracture, have penetrated, or crushed it throughout its whole thickness, and utterly destroyed its structure. To cut down, therefore, upon the depressed bone, and elevate or remove it, would have no effect whatever in restoring the functions of the cord.

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* For the prevention of sloughs, in cases of fractured spine, Dr. Brown-Séquard recommends a novel plan of treatment, in which he has much confidence. It consists in applying to the affected integument, in the first place, for a period varying from eight to ten minutes, a bladder containing pounded ice: he then substitutes for the bladder a very hot bread or linseed-meal poultice, which he directs to be kept on for one or two hours, or even a longer period. He adds: "I think I can safely say that, in cases where a slough is beginning, its progress will always be stopped by the means I propose." That treatment, he further states, was put to the test of numerous experiments on the inferior animals, before he adopted it in man. See his *Course of Lectures on the Central Nervous System*, 1860, p. 261.

Again, the advocates of the operation have never furnished a valid reply to the often-urged and powerful objection, that with rare exceptions—it might, perhaps, be correct to say, without any exception—the posterior arches of the vertebræ are never detached and driven in upon the spinal cord, unless there be at the same time fracture through one of the bodies, with displacement. Specimens preserved in museums prove it to be a general fact, that the fragments of the broken vertebræ which are indented into the cord and commit the greatest injury, are in front, not behind. It does not appear, therefore, that benefit can possibly be gained, so long as the principal cause of compression continues to exist on the fore-part, by extracting portions of the posterior arches.

But one of the latest and most strenuous defenders of the operation can perceive in that objection only an additional argument in favour of trephining. "These various operations," Dr. Brown-Séquard concludes his observations by saying, "or one or two of them, ought to be employed in almost all cases of fracture of the spine, especially in the cervical region, where pressure upon the spinal cord is attended with so much danger. The operation should be performed as quickly as possible after the fracture, and before inflammation has set in. If after having laid bare the spinal cord" (sheath?), "it is found necessary to reduce a fracture of the body of one or several vertebræ, the reduction will then be much easier, and attended with much less danger than if the vertebral canal had not been opened on its back part."* In other words, the author expresses his opinion, that the liberal division of the muscles and tendons at the nape of the neck, and making a chasm between the vertebræ, would render it easier for the Surgeon to replace the bones, and remove all causes of compression or irritation from the medulla. But he omits to inform us how the patient, thus all but completely decollated—the muscles of the neck extensively cut, the vertebræ deprived of their posterior arches, their bodies broken across, and the ligaments between them ruptured—should be able to hold up his head, or prevent its rolling to and fro, so as to crush the cord, supposed, before the operation, to have been sound!

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* Op. cit., p. 260.

The question of treatment which ought to supersede every one else is simply—the patient having received an injury of the gravest kind, likely to prove fatal, what method will most probably save life? Let any one consider the ulterior effects which may be reasonably expected to follow, in general, from such a wound as must be inflicted in trephining the spine. The incision must be both long and deep, being made through the skin and the muscles, and through the blood infiltrated in the torn structures, down to the broken bone. The main object of the proceeding being to remove the fragments, and to lay open the vertebral canal, the external wound will communicate not only with the fractured surfaces, but with the interior of the canal which contains the spinal cord.* To the mind of the Surgeon accustomed to witness the disastrous effects of compound fractures, the condition here described must appear the most formidable that can be conceived. He will look forward (if the patient should live) to profuse suppuration being soon established; to the pus penetrating extensively along the vertebral canal, between it and the membranous theca; to the exposed and isolated ends of the fractured vertebræ becoming necrosed; and he will not expect that, until these be detached and cast off (a process requiring many months for its completion), the suppuration will cease, or the wound cicatrise.

Faint, then, as our hopes of recovery in every case of fractured spine may be, instead of being exalted after such an operation, they will be absolutely extinguished. Experience acquaints us with cases not a few in which the paraplegia, supposed at first to have been produced by fracture and extensive destruction of the cord, has unexpectedly disappeared after having lasted for several days. When treating presently of concussion of the cord, the nature of such cases will be inquired into. The case of H. P., related at p. 228, shows that, even when the vertebræ have been positively fractured and displaced, the motor and sensory powers may be restored, after having been lost, and the patient lead an active life for many subsequent years. Examples are more numerous in which patients survive, without regaining sensation or power over their lower extremities. In reference to all these instances of recovery, it may be affirmed, that not one of the patients would have lived, if they had been subjected to the process of trephining. They would inevitably have perished from the conjoint effects of the accident and the operation. Let the young Surgeon's mind, therefore, be fortified against the influence of the authority in favour of the operation given by certain great men in the profession; let him feel assured that in abstaining from performing it, his forbearance is not neglect, but a positive duty to his patient.

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* Dr. Brown-Séquard considers it a recommendation of the operation, that, as the spinal canal must be opened, an opportunity will be given for blood extravasated into the canal to make its escape. "It has been objected that we often do not know whether there is a fracture of the posterior arch of the vertebræ or only of their body. Surely a mistake may be made in that respect, but the laying bare the spinal cord (*sic*) may be useful in allowing the escape of the bloody fluid effused in the vertebral canal. At any rate the worst would only be, that an operation which is not dangerous has been performed without profit." Op. cit., p. 257.

Concussion of the Spinal Cord.

The term concussion applied to certain injuries of the spinal cord is one recognised in all systematic works on surgery. Yet to assign a definite signification to the word is difficult. It would appear to indicate that a vibration passed through the medulla spinalis, the result of a corresponding vibration in the spine, like that which takes place in the brain when the skull rings from a blow; and that effects were produced by that concussion in the cord similar to those with which we are acquainted as symptoms of concussion in the brain. But the analogy does not in any single particular hold good. The anatomical relation of the cord to the vertebral canal is totally different from that between the brain and the cranium. And the physiological functions subject to be affected by the injury in the one organ are of an entirely distinct nature from those in the other.

Disregarding the name, let us endeavour to describe the kind of injuries to which Surgeons would apply the term; and reserve, as a separate question, the inquiry into the pathological condition of the cord.

If a person should meet with an accident, attended with general violence to the spine; and if, upon careful examination, the column should be found exempt from lesion, there being no signs of fracture or dislocation to cause distinct local injury, and if paralysis, either partial or temporary, were present, the case would be set down as one of "concussion." It may be best to illustrate the subject by an example.

In March 1841, a female, aged 60, was admitted, under the care of the writer, into the Middlesex Hospital, for partial paralysis, consequent on having fallen down a flight of steps. Repeated examination of the spine revealed no fracture or signs of injury at any particular spot. In both the upper extremities and in the right lower, voluntary power was entirely lost; sensation was merely impaired; she could feel on being pricked, and described the defect as "numbness." The left lower extremity retained both motion and sensation perfectly. She had retention of urine, afterwards incontinence; but in a short time she recovered the power over her bladder. By tickling the sole of the foot of the right lower extremity, and also when she sneezed, or elevated her voice, reflex actions were excited in the limb; but similar actions could not be produced in either upper extremity. Being of lively temper and voluble of speech, her lamentations were frequent; and as she lay uttering complaints, with both arms motionless by her sides, the head alone making gestures to enforce her words, she resembled a person confined in a strait-jacket—the likeness being increased by the right knee occasionally jumping of a sudden from the bed,—when her language became more emphatic. In ten days the power over that leg began to return; and shortly afterwards she walked with assistance across the ward; the foot, each time she lifted it, making gyrations in the air. About the same period, the arms were observed to be gradually acquiring some power; and they went on improving for a fortnight; but the progress after that was scarcely perceptible, or seemed to cease. It was remarkable that the parts which regained their power of motion, imperfect as it was, were different in the two arms: in the right, the restoration was confined to the muscles of the upper arm; in the left, to those of the fore-arm: hence the patient could bend and extend the elbow-joint, without having any command over the hand, on the right side; while in the left, it was the reverse,—she could grasp with the fingers, but was unable to move the elbow. Having been kept in the hospital above three months, subjected to various plans of treatment without benefit, she was discharged; and her subsequent history could not be learned.

In the above case it would be inappropriate to apply the word concussion to the injury; inasmuch as, in speaking of the brain, paralysis is not one of the symptoms included under that term. It would be more correct, if we are to follow the analogy of the superior organ, to use the word compression. It is greatly to be regretted, however, that, owing to the comparative rarity of cases of that kind, and the paucity of post-mortem examinations in connexion with them (a circumstance attributable to the patients' surviving the first effects of the accident, and being afterwards, in many instances, lost sight of by the Surgeons who originally attended them), the pathology of the subject is imperfect, and we are left much to speculation in attempting to explain the symptoms. But it is known that among the effects produced by fracture of the spine, one invariably met with is extravasation of blood in the immediate neighbourhood of the broken vertebræ, and particularly in the interior of the spinal canal. The escape of blood into that canal is caused by laceration of one or more of the numerous large vessels which entwine themselves as plexuses about the vertebræ. Now it is not unreasonable to suppose that cases occur in which the violence committed to the spine may have been too slight to produce actual fracture, yet sufficiently severe to occasion rupture of the blood-vessels referred to. If the spine, especially in an elderly person, has been much doubled by the accident, and the chest compressed, the return of the blood to the heart would be retarded, the venous sinuses congested, and their coats over-distended. Let it be supposed, therefore, that, in consequence of some sudden jolt or jar in the column occurring when the blood-vessels were thus swollen, a part of the network was ruptured, blood would be rapidly poured into the vertebral canal. It would flow, with scarcely any hindrance, into the free space between the theca and the sides of the canal,—with a facility incomparably greater than that with which blood is effused, in laceration of the meningea media, between the skull and the dura mater. Extravasated blood might thus find its way, without any limit, to any part of the canal. Accordingly, it would encroach on the space intended to be occupied by the cord, its membranes, and subarachnoid fluid. And the influence of this encroachment in suspending the functions of the cord by compression would differ, not only in correspondence to the situation of the chief pressure, but according to the changes of condition which the blood will undergo. When freshly thrown out, and yet fluid, we may conceive that one set of symptoms will be manifested; when the coagulum is soft, another; when the serum has been absorbed, and when firm, circumscribed masses of fibrin adhere to the parts around, a third kind. Nor should it be lost sight of, that while blood may escape abundantly into the canal, a considerable portion will penetrate along the nerves into the intervertebral foramina. By so doing, and by coagulating around the nerves in these narrow passages, the blood may either destroy or materially impair the functions of many. Hence, either independently of, or in combination with, compression on the cord, we may find symptoms which can only be ascribed to local affections of the nerves, at their exit from the canal.

It has been already stated that, however it may be with regard to diseases, it is uncommon in cases of injury, to find hæmorrhage occurring directly from the vessels of the cord; that even when the substance has been actually cut or torn by an intrusion of bone, in fracture, the quantity of blood effused is inconsiderable. Accordingly there is a marked difference in that respect between the brain and cord. From the effects of contre-coup in the former (independently of fissure or fracture of the skull—in cases of concussion of the brain apparently simple), we may expect to find patches of ecchymosis, from bruising, on the surface of the hemispheres; or if the violence has been greater, and followed by fissure, there will be extensive extravasation of blood. But in the spinal cord, ecchymosis, or effusion of blood on the surface, from injury to the vertebræ, is not an event to be expected in ordinary cases. If a superficial vessel be ruptured, it would appear that the blood which escapes is mixed with the subarachnoid fluid, which it tinges of a red colour; and that it does not form a clot on the surface capable of producing symptoms of compression. Should the injury be so severe as to pervade the cord in its whole thickness, and hæmorrhage occur within, the soft cineritious matter in the centre will be principally infiltrated with blood.

Another cause of paraplegia, temporary or partial, independent of fracture, or of extravasation of blood, yet succeeding an injury to the back, has been described. It is a change in the structure of the cord, supposed to consist of a slight disintegration of the minute tissues, such as might be produced by a vibration passing through its substance, and which lesion has been compared to the morbid condition of the brain conceived to exist in concussion. The disorganisation, according to that hypothesis, is not palpable to the senses; and the truth of the view is therefore beyond our power of either affirming or denying. Yet experience would lead us to conjecture that violent and abrupt flexion of a particular part of the spine, especially if accompanied with a sudden jerk or jar, would have the effect of bending the cord beyond its normal limits, and breaking up its structure to a greater or less degree; not so much, however, as to preclude the possibility of its recovering its soundness, and of having its functions restored after they had been lost. The following are the brief notes of a case witnessed by the writer many years ago; and he regrets that they are not fuller. A man, carrying a heavy bag of hops on his head, missed his footing and fell downstairs. When brought to the Middlesex Hospital the extremities were completely paralysed. He regained the use of his limbs in four days, and soon afterwards left the hospital. A few weeks after his return home he died of pneumonia. A small fracture was detected in one of the cervical vertebræ; but without inequality in the surfaces of the vertebral canal. The case was entitled 'concussion of the spinal cord;' but unfortunately the appearances of the organ have not been noted. It seems, however, allowable to conclude that, as one of the cervical vertebræ had been fractured, the neck of the patient must have been greatly bent or twisted in his fall downstairs; that the cord must have partaken of the extreme flexion; and that, although the parts returned to their natural positions, the cord must have received an inward injury, grave enough to destroy its functions for a period of four days, yet not sufficiently severe to preclude eventual recovery.

One important result of the discovery, of modern times,—that the nerves possess distinct functions from their roots arising out of divisions of the brain or spinal cord endowed with corresponding properties,—has been the demonstration, in the latter organ, of the particular columns which preside respectively over motor and sensory power. When a morbid process attacks the cord, and invades it slowly and gradually, from one part to another, it can be understood that the column to which motor power belongs may be disorganised before that to which sensation pertains; and that a part of the body will be deprived of motion, while sensation remains; or *vice versa.* But the same is not to be expected generally in lesions from violence. In accidents to the spine both functions are almost invariably lost simultaneously. And the reason is simple. The cord is small, and the columns possessing the distinct properties are in close juxtaposition. Hence an injury which would destroy one column, and deprive it of its function, could scarcely avoid destroying the other. Nevertheless, to assist in explaining certain exceptional cases of injuries to the column, in which one property has been abolished independently of the other, a few observations on the subject may be introduced.

It appears a general rule that motor power is more subject to be destroyed by itself, than sensation. And the anatomical structure, properly studied, would lead us to anticipate that such should be the case. The motor (anterior) roots of the spinal nerves are remarkable for arising superficially from their appropriate column. Instead of dipping deeply into its interior, they spread out flatly on the surface, dividing and subdividing into numerous minute radicles, before they attach themselves to the column. If structure has any significance, that peculiarity of origin must impress us with the belief that it is the exposed surface of the medullary matter of the anterior column, in which motor power principally resides. Again, the anatomy of the sensitive (posterior) roots furnishes an indication of the proper seat of sensation. Each fibril of these roots plunges suddenly into the interior of the cord. Instead of previously breaking up into radicles, like the anterior roots, every distinct fibril preserves its original size, and dives bodily, by the fissure between the posterior and lateral columns, into the centre. When they have arrived at the site of the cineritious matter, their exact terminations are not clearly discernible. By Sir Charles Bell it was shown that they kept apart from the posterior columns, formerly supposed to be their proper origins; and he believed that he could trace them, distinct from the cineritious matter, into the lateral column, where covered with that matter. The lateral columns he followed upwards to the medulla oblongata; and when he perceived that the root of sensation of the fifth cerebral nerve, analogous to the posterior roots of the spinal nerves, descended from the pons Varolii to the level of the first spinal nerves, and had its true origin in the lateral column, he concluded that it, and not the posterior column, was the seat of sensation in the spinal cord.* For our present object, however, the chief point of interest is, that the part of the organ to which sensitive impressions are first directed is situated deeply, and as it were carefully protected from the effects of injury. Accordingly, it may be deduced from these views, that the column of motion which sends off the anterior roots will be destroyed by violence inflicted generally on the cord, more readily than the column of sensation which gives off the posterior roots.

Inflammation of the cord and its membranes, succeeding fracture. Although it might be supposed that the condition of the broken ends, in cases of fracture of the spine, was likely to provoke inflammatory action in the important parts within the canal, experience proves that such occurrence is exceptional, rather than at all common. Sir Charles Bell has recorded two cases. In one, the eleventh dorsal vertebra had been fractured in its body, and the spinous process crushed; yet the spinal cord was not mechanically compressed. During the short time the patient lived, the symptoms were those of inflammation; he had high delirium, and threw his limbs about. Thick pus lay between the cord and its sheath, and serum was effused between the membranes of the brain. In the other, the ligaments between the last cervical and first dorsal vertebra had been ruptured, and the bones torn apart; for some time there was absence of paralysis; inflammatory symptoms supervened; and the upper and lower extremities became at last imperfectly paralysed. Extensive suppuration among the muscles around the injured bones, and within the vertebral canal, were the chief morbid appearances.* An interesting case of an analogous kind has been published by Mr. Simon, under the title "Latent Fracture of the Spine proving fatal by Suppuration within the Vertebral Canal."† The writer witnessed the following case. A man was admitted into the Middlesex Hospital for dislocation of the left femur on the dorsum ilii. The reduction was easily effected; but as soon as it was done, the femur became displaced as before; and it could not be preserved in its right place. In a few days he had acute pain in the back, with other symptoms of inflammation; and, without its being understood what was the cause of his dangerous illness, he died. On dissection it was found that the upper and posterior lip of the acetabulum had been extensively chipped off, so as to have allowed the head of the femur to slip easily out of the socket after it had been reduced. There was also, on the same side, a fissure of the sacrum, which ended at the vertebral canal in that bone. Flakes of lymph, and increased vascularity, in the membranes, and among the roots of the cauda equina, denoted that acute inflammation had been set up, by the fissure, in the interior of the canal.

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* *On the Nervous System*, by Sir Charles Bell. 1836, p. 233.

Other affections of the spinal cord, apparently connected remotely with injury to the spine, might be treated of in this place. The cases referred to are those in which paraplegia, beginning perhaps many months after a slight blow or sprain of the back, advances gradually and slowly till complete; and when the patient dies, it is found that the cord, without signs of inflammation of any kind, or positive disease in the vertebræ or joints, has undergone a process of degeneration, so that it has become semi-fluid or atrophied. It is proposed, however, to include these affections under the head of DISEASES OF THE SPINE.

ALEXANDER SHAW.

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* *Surg. Obs.* pp. 138-145.

† *Trans. of the Pathol. Soc.* vol. vi.

INJURIES OF THE FACE.

THE human face, the front and most exposed part of the body, would be more frequently the seat of injury were it not for its comparatively small size, the great mobility of the head, and the mechanically protective articulations of the forearm and hand. Of the first it is unnecessary to speak. As regards mobility, the head can bend backwards and forwards, and also rotate in no small circumference upon a horizontal plane; and to this the effect of the general mobility of the vertebral column is to be added. The obliquity of the inferior extremity of the humerus from without, downwards and inwards, brings the hand in flexion immediately in front of the mouth. With these means of guard, the head and face, guided by the eye, readily escape common accident; and those injuries which befall it are for the most part sudden, and often violent.

The skin of the face is not quite similar to that of other parts of the body. It is more abundantly supplied with minute vessels, which partake of the character of gland-vessels, in being able to propel, without the heart's influence, an additional amount of blood to the surrounding tissues. The nerves, the sebaceous, and sudoriparous follices are highly developed, and the dermal structure is intimately united to the layer of subjacent muscles, whose action, impressing lines upon the skin through the subcutaneous adipose layer, gives impress to the features, and imparts the stamp of character to the individual. The bones of the face lack the density of the bones of the extremities; they are either thin and paper-like, or thicker and spongy; but in both instances vascular, and little prone to exfoliation from common causes. They bleed when cut; they yield to distension, and are capable of recontraction; they are subject, moreover, to the morbid changes, such as are witnessed in softer tissues, and they unite readily when broken. Injuries to the face, then, may be appalling to the by-stander, but they excite far fewer feelings of dread in the mind of the Surgeon. A soldier in warfare receives a sabre-cut across the face; the wound may gape and look ghastly, but it is in general curable. An artisan is struck with a winch-handle violently upon the cheek; he is seen with distorted features and in wild delirium; but the stress of the injury is recognised as limited to the face: experience shows that the commotion of the brain will subside, and teaches that the prognosis is generally favourable.

Erysipelas is an accident which not uncommonly complicates these cases. Commencing about the seat of injury, it spreads over the entire head, where its presence is dangerous from the proximity of the brain, and the close vascular connexion between the parts within and without the skull.

But, these evils guarded against and avoided, there is still, in the event of recovery, the chance of deformity, of unpleasantness of expression, or of impairment of movement in parts essential to the integrity of an important organ, such as the covering of the upper lid to the transparent cornea of the eye. To all these points the Surgeon must direct his attention in the selection of such measures from the commencement as are best calculated to insure relief.

Bruises.

Blows on the face are commonly followed by extravasations of blood, which, as in the familiar instance of a black eye, are seen, in their various phases of transformation and absorption, passing through the shades of colour from deep brown, brownish or yellowish green, pale straw hue, to the natural aspect, through the thin integuments of the face. It not uncommonly happens that, in connexion with the bruise of the skin, there is extravasation of blood under the conjunctiva, or in the anterior, or even posterior chamber of the eye. These injuries are interesting, both pathologically and surgically. In the first instance, as showing what becomes of extravasated blood, and how soon it may become absorbed. In the second place, as affording an opportunity of testing how far we are in the possession of means calculated to assist and to expedite the efforts of nature.

I believe that, unless circumstances of unfavourable character interfere with the processes of repair, the rapidity with which effused blood is removed by the unaided action of the absorbents has been much under-estimated; it seems to be the very first step towards recovery, and its retardation implies the existence of some disturbing or morbid influence. In 1837 a boy aged ten was brought into St. Bartholomew's Hospital with a bruise on the brow, and with effusion of blood into the anterior chamber of the eye, from a blow, to such a degree that neither pupil nor iris could be seen. During the course of the night so large a quantity of the blood had been absorbed from the eye as to leave the pupil visible; and at the end of the sixth day from the accident the anterior chamber was clear, there being only a stain of blood upon the surface of the iris, indicating, in all probability, the exact spot where the blood-vessel had given way. So in bruises of the skin and subjacent parts, the removal of effused blood commences immediately upon the receipt of the injury, and goes on with a rapidity proportioned to the healthy state of the individual and the activity of circulation in the surrounding parts. Pugilists, who are brought into high condition by the usual system of training, recover from the bruises which they sustain in the exercise of their calling in from six to nine days. "However much a man may be beaten about the head," explained one of the fraternity to me, "he is 'himself again' in little more than a week, provided he keeps from drink, and takes an occasional dose of opening medicine." Experience has shown these men that they may take animal food with impunity, but that stimulants in the shape of drink interfere with and retard the removal of the bruise. The only exception to this statement respecting rapid absorption, is in the case of the effusion of blood between the conjunctiva oculi and the sclerotica. Here a space of four or six weeks is necessary for the removal of the stain; but, then, we must remember that in the normal state there are but few vessels of any kind engaged in active work in either tunic. We do not in the present day bleed a patient in consequence of a bruise; neither do we employ stimulating lotions nor frictions to the affected part. An evaporating lotion may be used if there are heats, and the patient feels the application grateful; but the best treatment consists in abstinence from drink (unless under exceptional circumstances), in rest, and the occasional administration of aperient medicine. I have not witnessed any clearly-marked beneficial effect from the employment of tincture of arnica, as recommended by many Surgeons. It may be used in the same strength as spirits of wine, in the proportion of one part to eight or ten of water, as a lotion, and it will at least serve to occupy the patient's mind. But the stories of its almost miraculous powers are without foundation, and exist only in the imagination. It may be rubbed into the bruised part, either undiluted, or mixed with an equal part of water; or the patient may use Friar's balsam, or any stimulating liniment instead. These applications serve only to excite the circulation, a measure usually unnecessary as regards the head and face, and capable, if in excess, of inducing a result totally opposite to that for which it was intended.

The practice of making a puncture into parts distended with extravasated blood, in order to preserve the vitality of the skin, is rarely necessary in injuries to the face. The only parts to which such a measure can ever be applicable are those where the subcutaneous tissue is very loose, and easily distended, the skin being of extreme tenuity, such as the upper eyelid; but even here we have rarely occasion to do so.

The question of rapid or of slow absorption of blood is one of practical importance; for by its proper solution we may justly estimate the progress of the case. In contrast with the rapid recovery of the pugilist, we may put the case of a pallid, feeble, and underfed woman, bearing upon her person the marks of ill-usage. It is no uncommon thing to see in such a person the mottled-yellow ring around the eye, telling its tale of the blow inflicted by a brutal hand, persisting, with but little change, for many weeks. Under such circumstances the treatment would be different, a more generous diet being advisable. But even here I question much the value of stimulating or other local applications. In the forehead, extravasated blood presents itself under two different conditions. There may be a simple cutaneous bruise, or there may be a collection of fluid blood under the occipito-frontalis. We have already discussed the former species of injury. The latter may be dismissed with a few words, as it will be found more thoroughly treated in the essay on INJURIES OF THE HEAD (p. 105). One of the larger vessels of the forehead, bruised or otherwise damaged by a blow, gives way some days after the accident, and pours forth a considerable quantity of fluid blood. An examination conveys to the hand of the Surgeon the sensation as if there were a circular depression of the skull surrounded by a sharp ring of bone. The explanation of this feeling is not obvious; it is in no way connected with the composition or the coagulation of the blood, for it is felt whenever fluid in moderate quantity is contained in a yielding yet thick-walled cyst. I have noticed it frequently in the examination of chronic abscesses in various parts of the body, such as the buttock, arm, or knee. Blood thus effused may slowly increase, from the fact of the vessel remaining open, and bleeding subcutaneously; or the bleeding may cease, when changes commence calculated to remove the fluid. If, at the expiration of some weeks, an opening be made through the skin (a practice by no means generally to be recommended), a thick brownish-black fluid escapes, composed of blood-discs, albumen, and a little water. The absorbent vessels seem to remove the greater part of the fluid material, and either to remove, or to deprive of its natural properties, the coagulating element of the blood. If, under the circumstances of an injury, coagulation should take place,—an event which must happen speedily, and before the absorbent vessels have had time to act on the blood, or else not at all,—the clot acts as a foreign body, and will excite, especially in persons of unhealthy constitution, inflammation and suppuration, under which processes it will be discharged.

In these cases we again witness from time to time the action of causes which retard the absorption of blood. Let the patient pursue his usual habits, and take the customary amount of stimulants; the integument covering the swelling becomes hot and puffy, and the blood beneath either remains the same, or even increases in quantity. Let the patient adopt another course, namely, keep himself quiet, avoid stimulants, be moderate in his diet, and keep the bowels open, and the swelling, which was enlarging, first becomes stationary, and then disappears. A boy aged seven was struck, July 1, 1838, on the right temple, towards the outer angle of the eye, by a stone, which was thrown at him by another boy in anger. A small wound was inflicted, which speedily healed; there was scarcely any bleeding at the time. The lad pursued his usual habits, and, a fortnight after the accident, found his head heavy and uneasy, although free from pain. The mother detected, in the situation of the cicatrix of the wound, a soft swelling, which increased in size until he was brought to St. Bartholomew's Hospital, where he was admitted July 19. There was a large fluctuating and irregular swelling caused by the elevation of the integument by fluid. The sensation of "depression of bone" was communicated to the fingers. He was ordered aperient pills, and a cold lotion was applied to the head. On the 23d of the month, no change being noticed, a puncture was made, when about four ounces of dark-coloured fluid blood escaped. The peculiar sensation resembling depression of bone was yet more evident. In three days he was convalescent, and discharged well towards the end of the month.

After very severe injuries involving fracture of the skull and injury to the brain, blood-stains and ecchymoses about the eyes remain unchanged for many days, or even weeks. Their existence is merged in the greater injury, and they are only important as a signification, by their persistence in doubtful cases, of the existence of some serious complications. After severe injuries to the great nervous centres, all vital processes are depressed and in part suspended.

We read of bruises, wounds, and other injuries of the frontal, and sometimes of the infra-orbital nerve, followed by amaurosis;

and authors have endeavoured to explain the connexion between the two. I have seen both nerves divided, and otherwise injured; the frontal nerve frequently, in cases of surgical operation and accident, and no instance ever came before my observation in which the injury to the nerve seemed to exert the least effect upon the organs of vision. A severe blow with a stick or sword upon the brow may be followed by immediate blindness, whether it divide the frontal nerve or not. But, then, the loss of vision is due to concussion of the retina, to rupture of the minute blood-vessels which ramify in that delicate nerve-layer, or to some other internal disorganisation; and we must in this way explain the case which Petit brought before the Academy of Surgery, namely, that of an officer who became completely amaurotic in consequence of a sword-wound in the eyebrow. To this same opinion the late Mr. Tyrrell inclined; he denied the existence of sympathy productive of such serious results between the fifth and the optic nerves, and referred the loss of vision to concussion of the retina. In the same way, I question the accuracy of the observation by Mr. Wardrop, that a partial, but not a complete, division of the frontal nerve will sometimes produce amaurosis; and likewise the advantages of the method of treatment founded on that opinion, namely, to cut down and completely divide the nerve in question. "I have met," says Dr. Hennen, "with one or two cases of amaurosis from wounds of the supra-orbital nerve; the perfect division of the nerve produced no alleviation of the complaint; but after some time the eye partially recovered." "When defective vision follows a wound in the forehead," said the late Mr. Guthrie, "the only hope of relief, that we are at present acquainted with, lies in a free incision down to the bone, in the direction of the original wound: and even of the efficacy of this, I am sorry I cannot offer testimony from my own practice, *having failed in every case in which I tried it*."* It is not easy to explain Vicq d'Azye's experiments upon this subject. He laid bare, in a variety of animals, the frontal and superciliary branches of the fifth pair; he bruised and tore the exposed nerves, and convinced himself that this was speedily followed by blindness.† I divided the frontal nerve in two rabbits, in the month of February 1839, in order to verify the former experiments. After bruising and cutting the nerves in more places than one, I allowed the wounded parts to heal. No sensible effect was produced in the vision of the animals. In the summer of 1857, I assisted Mr. Lawrence in the operation of dividing the infra-orbital nerve in a lady, of middle age, who had been a most severe sufferer from neuralgia. The sight remained the same, although the severment of the nerve-fibres in that situation is attended with a considerable amount of bruising.

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* *Lectures on the Op. Surg. of the Eye*, p. 102, 1823.

† *Journal Complémentaire des Scien. Méd.* vol. xliv. p. 201, 1832.

But the use of the ophthalmoscope renders the diagnosis in those cases far more accurate and certain than in former times; and for the mode of its application, the reader is referred to article INJURIES OF THE EYE.

A divided nerve unites as readily as any other organised structure; and the usual functions are restored when the connecting processes are completed. The nerve-fibrils pass through the effused fluid, and adapt themselves accordingly. Mr. Quekett, of the Royal College of Surgeons, possesses a specimen showing this process of union; and of its completeness we have abundant illustrations in cases of accident to other than the frontal nerve. The external popliteal nerve is sometimes cut through by the Surgeon, in the division of the tendon of the biceps flexor cruris. The loss of sensation and motion, which is the immediate result, to the great dismay of the patient, is after some weeks completely restored. Such a case occurred in the private practice of the late Mr. Lonsdale.

WOUNDS.

The treatment of wounds of the face consists, as in the case of wounds in other parts of the body, in holding the divided surfaces in apposition until nature has had time to throw out a new connecting medium; only, in the face, more than usual care is required to maintain the parts in their exact normal relation. Let us imagine the unpleasing effect produced by the imperfect adjustment of a divided eyebrow. Mr. Lawrence once had to reopen a healed but badly-adjusted wound in this situation, in consequence of the unpleasant expression it conveyed to the features, and to cause it to reunite in a more accurate manner. Wounds of the eyelids, particularly when attended with loss of substance, may be followed by eversion or ectropium; and wounds of the nose and lips, badly treated, may injuriously affect the functions of the organs of which they are the instruments. I do not recognise the "immediate union" of Dr. Macartney; that is to say, that the divided bloodvessels and nerves are brought into perfect contact, and union takes place in a few hours; and as no intermediate substance exists in a wound so healed, no mark or cicatrix is left behind. The union of divided surfaces, without the assistance of a new connecting medium, appears to me a self-evident impossibility. But the surfaces of a wound may be so accurately brought together, that the thinnest possible layer of connecting material may suffice for the reunion of the cut parts; in which case no evident cicatrix will follow. In all cases, therefore, whether we employ plasters or sutures, our endeavour should be to hold the wound together until the natural union by effused lymph is sufficiently strong to dispense with artificial assistance.

A clean cut on the forehead does not always need a suture; the necessity depends upon the gaping of the wound. If, as is commonly the case, the edges keep in apposition, a few strips of plaster are all that is required; and let not the Surgeon remove them for some days, unless heat and swelling supervene. Nothing interferes so much with processes of repair as constant changes of plaster, washings, and examination; a wound heals readily under an incrustation, or a hardened clot of blood, if left to pursue its own course, in a healthy subject.

Wounds involving the eyebrow should always be united by a few points of the interrupted suture, care being taken that the edges are quite clean. The shape of the eyebrow should be considered, and the first suture should be so inserted as to prevent any irregularity in that important feature. As regards division of the upper eyelid, an accident comparatively rare, no definite rule can be laid down. The part may be united by suture to the integument of the brow, if torn or separated therefrom; but the whole thickness of a divided eyelid should not be transfixed by a suture, one part of which must of necessity press upon and irritate the globe of the eye. Generally speaking, the prominent and convex globe forms an excellent support to the divided lid, and a few thin narrow strips of plaster, passing transversely as regards the wound, covered by others which, applied vertically, strap the lid down, and prevent the patient opening the eye for a few days, are quite sufficient for the purpose. In some severe cases, the swelling about the brow and cheek has been so great, that the lids have remained closed for several days: under such circumstances, the application of a damp cloth is all that is needed. Hare-lip pins are quite out of place in wounds of the eyebrow; the desired end can be obtained, doubtless, by their means; but the proceeding is unnecessarily irksome, and possesses no advantages over the suture. The metallic suture should be used, if the Surgeon happen to possess the necessary material; but for all usual emergencies a small needle, slightly curved towards the point, armed with a fine round silken ligature, will be found sufficient. There is no absolute necessity for the patient to have the face constantly covered with a wet cloth. He may consult his own feelings; and the Surgeon may remember that the process of union goes on most favourably under the thin dry line of blood marking the well-adjusted wound.

A vertical wound of the upper eyelid, passing through its whole thickness, the edges of which have cicatrised separately, leads to a deformity which has been termed *coloboma.* At the present time, however, this word is used generally to designate the congenital variety of the deformity. It must be rectified by an operation similar to that of hare-lip, excepting the employment of a hare-lip pin. A sufficient amount of union may be maintained by fine sutures, and the closure of the lid over the globe of the eye by strips of plaster. The necessity never happened to me to perform this operation. "I have seen a case," observes Mr. Lawrence, "in which, a horizontal wound of the upper lid having been neglected, a sort of button-hole was formed, from the edges not having been kept in apposition; what was worse, accretion of the conjunctival surface of the palpebra to the globe had taken place, and the lid hung so much over the globe as to render the eye almost useless." I have seen the same under circumstances of disease, where ulceration of the eyebrow and upper lid has ensued from syphilitic periostitis of the frontal bone. In such cases, the amount of disease still going on, or liable to return, renders operative interference unadvisable.

As regards wounds of the external ear or of the nose, the rule is absolute in surgery, that, whatever be the amount of injury, the parts should be carefully cleaned, replaced, and held in apposition by a few sutures and fine strips of plaster. Results which surprise even the experienced are thus obtained in the most unpromising cases; and the deformity is comparatively inconsiderable.

We read of cases of the division of Stenon's or Wharton's duct, of the establishment of a salivary fistula, and of the necessity of a plastic operation. The subject will be more fully discussed in the article on PLASTIC SURGERY. But I may remark that I have never seen a simple wound of the face in any situation followed by the accident here referred to. Monro states that the duct has been wounded by the surgeon's lancet; and Desault, that it has been ruptured by a blow; and the latter gives minute directions, which are commonly quoted in surgical works, as to the mode in which the continuity of the canal is to be reëstablished and maintained.

He recommended the introduction of a seton through the canula of a small hydrocele trochar into the mouth; the wound was dressed daily, lint and a compress being applied to the cheek. Those who wish the details of this operation may consult *Œuvres Chir. de Desault*, par Bichat, t. ii. p. 221. I have had no experience of the use of the actual cautery, nor of the employment of a wire heated by an electric battery in these cases, although such means have proved of great avail in the closure of fistulæ in other situations. Rodolfi gives the particulars of a case in which he closed the opening by means of collodion.*

Wounds involving the whole thickness of the lip are usually united by the hare-lip pin and sutures. In all cases it is important to preserve the line of red margin to the lip; and this is best effected by a very fine needle and suture. But the metallic suture introduced by means of Simpson's grooved needle possesses the advantage of exciting so little irritation, that four or five days may elapse without any surgical interference. The wound should then be held together by fine strips of plaster passing round the entire head, by which the traction on the newly-formed material is prevented. An instrument for pressing together the cheeks has been invented for the same purpose. Collodion is rarely used as an application in wounds of the face; it drags too forcibly and unequally on the surrounding structures, and presses the blood from the capillary vessels, by which the process of repair is retarded.

Foreign bodies are occasionally introduced, more particularly by children, into the ear and nose. They should be removed from both situations, provided this end can be accomplished without pain to the patient and with ease to the Surgeon. But when it is remembered that, if left alone, the foreign body generally becomes loosened, and escapes without surgical interference of any kind, we shall have a very strong argument against the adoption of any means involving suffering. No cases similar to those related by Acrel in 1778, and by Morgagni and Valsalva, of worms making their appearance in the auditory passage, have been noticed of late years; Surgeons have not been called upon to treat cases of convulsions dependent on such causes; and the practice of injecting the distilled water of St. John's-wort, in which mercury had been agitated, for the purpose of destroying the worms which remained, has gradually fallen into merited disrepute. Mr. Samuel Cooper saw the case (1829) of a child aged two years and a half, into one of whose ears a pebble, and into the other a French bean, had been pushed by another child, and remained there ten months, causing complete deafness and extreme suffering. These bodies were removed by the forcible injection of tepid water and the use of a bent probe. In all probability the meatus had become widened.

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* *Gazz. Lomb.* iii. 1854.

I saw, in August 1859, a child about three years old, at Epping (a patient of Mr. Duncan Macnab, of that town), into whose ear a small oblong pebble had been introduced, just of sufficient size to occupy the auditory passage. There was no difficulty in touching and even moving the stone, but in every attempt to seize it with a pair of forceps the ends of the blades slipped off and jerked the body further towards the tympanum; and the introduction of a bent probe, or thin piece of metal, was impossible, owing to the narrowness of the passage. Mr. Macnab determined, in the absence of any urgent symptoms, to wait and see what course nature would pursue. The following day, amidst a considerable quantity of thick puriform discharge, the pebble presented itself at the external orifice, where it was easily and without pain extracted by a bent probe, and the little patient had no bad symptoms. We should remember that the auditory passage is widest at the external orifice; then it narrows somewhat, and becomes wider again towards the membrana tympani. Thus foreign bodies, particularly when round or oval, can with difficulty be handled when they have passed into the contracted part of the tube. Singular stories are told of the effects produced by their long residence in the ear. Hildanus affirms that he cured a young girl of epilepsy by accidentally removing from the ear a foreign body which had been introduced seven years before, and had been quite forgotten! Small forceps and scoops are made to assist the Surgeon. One of the most useful instruments is a long flat steel probe, the end of which can be made to bend to a right angle by a screw fixed at the handle. (Vide SURGICAL APPARATUS.)

Directions are given that such instruments should be introduced along the upper, rather than the under, wall of the meatus auditorius; that when the handle is raised so as to bring the end of the instrument over the foreign body, the point may recede from the membrana tympani, which is oblique in its direction from above downwards and inwards. It is unnecessary to condemn the unscientific suggestion of Duverney, namely, to make an incision behind the ear for the purpose of gaining space, for it must obviously be on the outside of the extraneous substance. Moreover, the cartilaginous external ear is a part on which the performance of a surgical operation is productive of the most severe pain. I remember the removal of a large part of the external ear, by Mr. Lawrence, at St. Bartholomew's Hospital, from a man, the subject of chimney-sweep's cancer; and the patient, though rendered unconscious by the administration of chloroform, struggled so convulsively and uttered such loud cries, as to attract the observation of those present. The great danger arising from the presence of a foreign body in the ear is, that it should excite ulceration of the membrana tympani, and, falling into the middle ear, produce by its presence inflammation of the temporal bone. The compact structure of the petrous portion of the bone is ill able to withstand morbid processes; it soon dies, and sets up inflammation in the neighbouring substance of the brain. The patient, after undergoing agonising suffering, dies, labouring under cerebral symptoms; and upon examination after death, an abscess is found, not uncommonly in the cerebellum, containing a greenish-coloured matter, occasionally fœtid, and surrounded by ragged and discoloured brain-substance. For such an occurrence we have but limited means of treatment. We read of cases in which paralysis of the arm or leg suddenly supervenes, of the occurrence of delirium or coma; and pathological investigation shows that the sinuses, namely the longitudinal, lateral, and petrosal, may be full of pus and lymph, proving that the patient has been attacked by intracranial phlebitis, as well as by disease of the brain itself. (Vide DISEASES OF THE EAR.)

Foreign bodies introduced into the nose cannot excite the same dangers as in the former situation. They may in general be readily removed, either with the polypus-forceps or the scoop; the only danger attending the operation is that of breaking the spongy bones, or of pushing the substance backwards into the pharynx. Let it be remembered that, in children especially, there is no cause for anxiety or haste; the extraneous body will work its own way out, the surrounding parts receding so as to widen the passage by which it entered. I was once consulted by a patient suffering from discharge from the nose, and found that the end of a style introduced some years ago down the lacrymal canal, but covered by the integuments of the face, projected into the inferior meatus. The removal of the instrument relieved the patient. A young man consulted Mr. Lawrence in consequence of his suffering from discharge from the left nostril, accompanied with enlargement of the corresponding superior maxillary bone, which was soft and yielding.

A probe introduced into the socket of the second molar tooth passed readily into the antrum, and allowed the escape of some thin sero-purulent fluid. In the course of a few weeks a small bit of lint escaped from the antrum through the socket of the tooth, the discharge from the nose ceased, the cheek regained its normal size, and the man recovered. It turned out that the lint had been used, steeped in laudanum, for plugging the socket and relieving a temporary attack of face-ache.

The presence of a foreign body in the nostril may become the cause of ozæna, and lead to the secretion of a fœtid puriform discharge; and attention has lately been directed to this subject by some of the Surgeons of St. George's Hospital, who have pointed out the propriety in doubtful cases of careful examination, under chloroform, of the affected part. In September 1859, two little boys, between six and seven years of age, came under the care of Mr. Prescott Hewett. The first was said to have passed a plum-stone up the nose, and the event was supposed to have taken place a year previously. On examination, some foreign substance could be recognised, with the probe, high up in the nostril, and wedged against the spongy bones. It was impossible to deal with it until chloroform had been given, and this having been done, a long screw (more than an inch in length) was with some difficulty extracted. The child soon recovered. The other had been under the care of various practitioners for the last three years, on account of "discharge from the nose," "ozæna," &c., but without any suspicion entertained of a foreign body being present. On examination, Mr. Hewett recognised, at the top of the nostril, a black-coloured substance, which seemed hardly like a portion of the natural tissues. The child was therefore put under the influence of chloroform, and a small black button (such as is used on boots) was extracted. The ozæna and discharge from the nose soon disappeared.* Another case has been described, in which a piece of wood-shaving was removed under similar circumstances.

For the treatment of the scars resulting from burns and scalds of the face, vide PLASTIC SURGERY. I may here remark, that, after the application of heat in any form to the integument, the great point to ascertain is, whether the entire thickness of the skin has been destroyed. If only the superficial layer has been disorganised, repair goes on, without subsequent contraction, by means of a number of small florid and well-formed granulations. If, however, the whole thickness of the integument is involved, then to a certainty contraction will follow. The eyelid will be drawn downwards, producing ectropium; the nares may be narrowed and twisted; the mouth drawn downwards and to one side, exposing the teeth and jaw. The features cease to be in harmony, and the teeth become horizontal. Surgical skill is often in vain invoked to arrest the contraction; it goes on steadily and slowly, however we may arrange the plasters and dressings, or in whatever position the patient may be placed. It is in general after a lapse of years that relief from the deformity is sought; and then the disappointment attending plastic operations, or partial divisions of the contracted bands, has been too generally experienced to need comment. I would call especial attention to the treatment of these contractions by slow, gradual extension, the advantages of which proceeding merit more general attention: the contractile material of the cicatrix becomes slowly absorbed, and when once absorbed is not reproduced; the hard and puckered skin becomes soft and yielding, though never like healthy integument; and results are ultimately attained which surpass expectation. The objection to this practice, that it is slow and involves a treatment of many months, is not tenable, for the treatment of wounds made in the performance of plastic operations on cicatrices is very frequently more tedious still; and then it must be remembered, that after the wound has healed, a process of contraction goes on again in every part allied in its nature to a cicatrix, and in many cases the surgical operation has to be repeated.

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* *Brit. Med. Journal*, Sept. 24, 1859.

Cases occasionally present themselves in which the cheek becomes adherent to the gums, in consequence of sloughing of the lining membrane, and subsequent granulation and union of the adjacent surfaces. The movements of the mouth are always so much impaired that the power of mastication is lessened; and it occasionally happens that the teeth are so firmly clenched, that there is difficulty in giving to the patient the necessary nutriment. I saw, in 1845, a lady to whom this accident had occurred, after profuse salivation, directed for the purpose of relieving her from an attack of psoriasis. The soreness of the mouth caused by the mercury was aggravated by the presence of some carious teeth, which the Surgeon refused to remove. A very strong band of adhesion formed, which was twice divided by another Surgeon; the relief thus afforded being temporary, and the closure of the mouth recurring in the course of a few weeks. About the same time I saw a boy, all of whose teeth were sound, but in whom sloughing of the mucous membrane of the cheek had taken place during the course of some eruptive disorder. Two cases very similar to the last have been lately treated in St. Bartholomew's Hospital. In the first, a young girl of fifteen years, a single band of considerable thickness had formed on the right side of the mouth. It was extirpated by operation down to the healthy structures; but, as cicatrisation proceeded, the mouth would have closed again, had not small ivory wedges been introduced between the teeth, and retained there by night as well as by day. In the second case, a boy aged ten, the adhesions were more general: no operation was performed; and a limited amount of benefit was obtained by the employment of the ivory wedges. There was a case of contraction of the mouth in a man, a patient at the Royal Orthopædic Hospital (in 1859), who had been a sufferer from rheumatic disease of the articulation of the lower jaw. The tissues round the articulation were hard and unyielding, and scarcely permitted the least separation of the teeth. Considerable relief was obtained by slow extension. In all these cases, whatever may be the primary cause, the rule to observe is, to avoid as much as possible the use of the knife. Division of the morbid parts must be followed, however skilfully the operation is performed, by the formation of a fresh cicatrix, in which the tendency to contraction will exist to the same extent as in the original cicatrix. Indeed, the mouth becomes stiff during the night while the patient sleeps, unless the jaws be kept artificially open. The treatment by the introduction of wedges of gradually increasing size is founded on this recognised principle, that pressure, however gentle, will, if steadily and unremittingly persevered in, gradually overcome the most powerful resistance; and experience shows us that, under such a process, the strongest bands of adhesions become elongated, absorption removing that part of their tissue in which resides the tendency to recontract. Consequently, when the mouth has once been opened by such a plan of proceeding, it is found on examination that the newly-formed tissue has lost its hardness, and that the advantages which the patient has derived are permanent.

Hæmorrhage from the ears, after injury, is commonly regarded as an indication of fractured skull; and such indeed it is, provided the flow of blood be copious. But there are other cases in which the hæmorrhage is not considerable, and seems to proceed from the lining membrane of the external ear, without the more serious complication. A boy was admitted into St. Bartholomew's Hospital, December 14, 1843, having fallen on his head from a pillar six feet in height. His parents noticed that he was taken up insensible, blood flowing from both mouth and ears. His shirt was stained with blood. At the time of his admission he was just able to speak and answer questions. The head was shaved, and a cold lotion was applied; no bad symptom supervened, and he was discharged well within a month. Such cases are by no means uncommon in hospital practice, and may, with a little care, be readily distinguished from those of more serious character, in which the flow of blood depends on fractured base of the skull, and laceration of some of the venous sinuses. (Vide INJURIES OF THE HEAD.)

FRACTURES.

Fractures of the ossa nasi are not uncommon, and are usually attended with depression. In the Museum of St. Bartholomew's Hospital, there is a preparation showing the "union of a transverse fracture of the ossa nasi a short distance above their lower border;"[*] but swelling and ecchymosis often render the diagnosis at the time of the accident difficult. When replacement of the depressed portions is practicable, the Surgeon must introduce into the nostril some such instrument as a female catheter, or a pair of dressing-forceps, and apply pressure in the right direction. He is recommended to plug the nostril, when the tendency to displacement remains; but I do not approve, as a rule, of distending the nostril with a foreign body. It was remarked by Sir C. Bell, that no tubes can be employed so as to support the broken bones; and when these have been replaced, they will not readily change their position, as they are acted on by no muscles. Hæmorrhage may be profuse for a time, but usually ceases spontaneously, or upon the application of cold. Plugging the nostril should not be resorted to except in cases of severe displacement of the bone, for it causes the patient great discomfort, and not uncommonly fails to effect the purpose for which it is used. Cases occur in which the septum nasi, together with the crista galli and cribriform plate of the ethmoid bone, are driven upwards to the skull; and there may be injury to the brain and escape of cerebral matter. The fracture of the facial bones is here comparatively unimportant; and the injury must be regarded as a variety of fracture of the base of the skull, of which the rules of treatment are given in the essay on INJURIES OF THE HEAD. In the same way, injuries of the lachrymal bone involving the nasal duct, will be considered under the head of INJURIES OF THE EYE. The eye may be bruised by the same injury which has broken the nasal bones, but it is rarely affected secondarily by inflammatory disturbance.

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[*] Ser. iii. prep. 75.

Mr. South relates the case of a man who was struck on the face with the handle of a crane, and in whom all the bones were separated and loosened, "feeling like beans in a bag." The bones may be crushed by the passage of a bullet, or by a fall on the face from a great height. The chances of recovery depend upon the amount of injury which has been sustained by the brain. We have no means of setting or adjusting the broken bones, and we must be content with general treatment. The teeth are commonly loosened, or completely detached. In the former case it should be remembered that they may again become firm, and should be left *in situ.* A completely detached tooth replaced in the socket may, it is true, contract some adhesion to the gum; but sooner or later it acts as a foreign body, and, after exciting irritation, falls out, to the great comfort of the patient.

Hyrtl remarks, that an observation by Pétrequin and Bouchacourt on injuries in this region is of importance in a medico-legal point of view; namely, that wounds of the face caused by the violent action of blunt instruments have often the same appearance as if inflicted by the sharp cutting edge of a knife. The sharp border of the superior maxillary and malar bones, or the edges of the teeth, will, when a blunt body presses against them, cut through the skin and subjacent soft parts, and cause an injury closely resembling an ordinary incised wound.

Middeldorpf* relates a case of fracture of the upper jaw and malar bone, together with fracture of the vomer and ethmoid, accompanying fracture of the lower jaw, from a fall. He points out the possibility of a fracture of the upper jaw in consequence of a blow upon the chin. The symptoms, resembling those of fracture of the base of the skull, which sometimes accompany fracture of the malar bone, have been already referred to under INJURIES OF THE HEAD, p. 127; and some further observations on the treatment will be found at p. 266.

Fractures of the lower jaw. The lower jaw is the strongest of the bones of the face; the lower margin of its body is more prominent than the upper, which is composed of alveoli, and contains the teeth: the front surface is therefore oblique, from below upwards and backwards; and this obliquity becomes the more marked as the teeth drop out and the alveoli become absorbed in the processes common to old age. Indeed, in the jaw of a very old person, the mental foramen approaches the upper border of the bone. The rami are nearly perpendicular to the body in middle age, but in both very old and very young the direction is obliquely backwards, and approaches the horizontal. The strongest part is the symphysis, or that part where the two halves of the bone, separate in fœtal life, become coalesced in the course of development. In this immediate spot fracture rarely occurs, the bone usually giving way a short distance either to the right or the left, where it is thinner, in the space between the symphysis and the insertion of the masseter. In other cases, the fracture occurs at the angle, or in the ramus of the jaw, the coronoid process, or the condyle. The bone may be broken in more than one place; fracture may be combined with dislocation. Bonn* gives an account of fracture combined with dislocation of the condyle of the lower jaw. There was a longitudinal fracture in the middle of the bone, and at the same time the right condyle was broken off from the neck, and dislocated forwards and inwards, where it lay united by callus, near to the foramen ovale (foramen maxillare posterius). The pointed upper extremity of the neck of the lower jaw articulated with the glenoid cavity, and the separated "head" with the lateral part of the tubercle of the temporal bone. There was motion in the joint. The same author mentions a case of fracture and dislocation of both condyles of the lower jaw. In a young man, who had had numerous other fractures, and who died five weeks after the accident, there was found, besides a longitudinal fracture of the middle of the bone, fracture and complete separation of both condyles, which were drawn forwards and inwards as in the preceding case, and fixed by callus, not far from the foramen ovale, on either side. On the left side, the articular or glenoid cavity was externally rough and uneven, and surrounded by a rough callous border; on the right side it was divided into two parts, of which the inner was hollowed out and smooth; the other uneven, and surrounded by a prominent callous ridge. The smooth cartilage-covered condyles were in contact with the cartilage-covered tubercle; the pointed upper extremity of the neck of the lower jaw, with the uneven surface of the glenoid cavity.

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* *Beiträge zur Lehre von den Knochenbrüchen,* von Dr. A. Th. Middeldorpf, Breslau, 1853.

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* A. Bonn, *Descriptio thesauri ossium morbosorum Hoviani*. Amstelædami. 1783-4; and ejusdem *Tabulæ ossium morbosorum præcipue thesauri Hoviani*. Ibid. 1785-8; or Gurlt, *Beiträge zur pathol. Anat. der Gelenkkrankheiten*, p. 122, Berlin, 1853.

During the course of the present year (1860), Mr. Holmes exhibited at the Pathological Society of London a specimen of a fractured portion of the neck of the lower jaw driven into the meatus auditorius externus. The accident was followed by serous discharge from the ear, simulating one of the symptoms of fracture of the petrous portion of the temporal bone at the base of the skull. The diagnosis of such cases is treated of under the head FRACTURES OF THE BASE OF THE SKULL. J. L. Petit mentions a case in which the bone was broken and the coronoid process completely denuded by a kick from a horse. Surgical writers have affirmed that serious cerebral and nervous symptoms may accompany fractures of the lower jaw; the former due to the amount of general violence which accompanied the local injury, the latter to laceration of the dental nerve in its course through the canal in the bone. The cerebral symptoms here referred to would be accidental, such as might accompany an injury in any other part of the body. The nerve-symptoms mentioned have not hitherto been witnessed by me in any such case; and Middeldorpf,* who has written on the subject, affirms, that "laceration of the *nervus alveolaris* never excites dangerous complications." He records nine cases, and remarks that the displacement of the bony fragments is very often due to the direction of the force rather than to muscular action. It is unnecessary to remark upon the proposal of Fattori, to trepan the front wall of the jaw in cases of neuralgia, and to cut out or otherwise destroy the nerve.

Non-union, or even tardy union, of fractures of the lower jaw is very rare. In the *London Medical Repository* for 1823, a case is noticed in which Dr. Physick cured such a case by means of a seton; and Ancelon relates the following case, in which the want of union appears to have been due to disease, perhaps partial necrosis, caused by the unnecessary amount of violence. A farrier presented himself with double fracture of the lower jaw, which had not been treated for five months. He had allowed a brother farrier of powerful frame to pull out a tooth for him, and in the act the whole middle piece (*i. e.* body) of the lower jaw was broken off a short distance in front of the masseters on either side. Upon examination, five months after the accident, M. Ancelon found the middle piece movable and producing crepitus on the opposed surfaces; the gum was thick and infiltrated, and the smell from the mouth almost unbearable. In consequence of some misunderstanding, nothing was then done, although the Surgeon felt inclined to remove the whole bone. A year and a day afterwards the man returned, wishing to get rid of his present suffering at any price. The left ramus of the jaw had been entirely separated and lost: the cicatrices by which it had come away being quite visible: a firm band was felt under the skin, passing down in the same situation to the middle piece of the jaw. The middle piece still contained one canine, two bicuspidate, and one molar, teeth. The right ramus remained in the socket, but the broken end was pulled up and pushed into the soft parts. The whole cheek was swollen; the angle of the jaw was carious and protruded through the skin. M. Ancelon removed the entire right ramus. The middle piece remained attached to the fibrous cord on the left side, and the patient regained sufficient power to masticate light food.*

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* *Beiträge zur Lehre von den Knochenbrüchen*, von Dr. A. Th. Middeldorpf, p. 52, Breslau, 1853.

When fracture occurs about the middle part or body of the lower jaw, the signs are sufficiently obvious. There is mobility of the parts, crepitus, and irregularity in the line of the teeth; the gums are torn and bleeding, the mouth is usually partly open, and the saliva dribbles away. It is commonly affirmed that, when the middle portion is broken on both sides of the symphysis, the detached fragment is drawn down by the depressor muscles of the lower jaw: such is sometimes the case, but the direction of the force applied must also be taken into consideration, as well as the inclination of the fractured surfaces. When fracture occurs in the ramus, or about the neck or coronoid process of the bone, the displacement is either inconsiderable, or else in such a situation as to be recognised with difficulty. The Surgeon must then trust to careful examination and inquiry into the character of the accident, remembering that the presence of deep-seated fixed pain, on examination, in a bone, after a severe injury, is a good diagnostic mark of fracture. There are some who speak of "compound" fracture of the jaw, where the gum is lacerated or the integument torn. The term, perhaps, is scarcely applicable in the sense in which it is used in cases of fracture of the long bones. In the latter the gravity of the complication consists in the laceration of the mass of soft parts, muscles as well as integument, covering a dense hard bone, such as the femur or humerus. Inflammation and suppuration are apt to ensue, producing exhausting discharges and hectic fever. In the former case, the laceration of the gum, or of the integument covering the jaw, is a matter of comparatively little moment; it adds nothing to the severity of the case: the soft parts unite readily enough, being a thin and highly-organised layer. The bone, also, more highly organised than the long bones, throws out, without effort, the proper material for repair. Beyond, therefore, the pain which such an accident causes, there is little ground for anxiety in ordinary cases either to the Surgeon or to the patient.

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* Double Fracture de la Machoire inférieure, *Gaz. des Hôpit.*, 1854, p. 550.

The treatment consists in maintaining the parts in steady apposition for from four to six weeks. During this period the patient must not attempt to chew solid food; he must live on soups, sopped bread, and other similar substances, which can be swallowed. He will not feel disposed to talk much, and, in so doing, should avoid moving the jaw. As a rule, he will content himself with merely expressing his wants. If the fracture be not attended with much violence to surrounding parts, there is no necessity to prescribe absolute rest; but, in cases where the soft structures are much lacerated and bruised, bed is the fittest place until swelling has entirely subsided.

Various substances are employed for the manufacture of a splint. That in most common use is gutta-percha, which, when properly heated, adapts itself accurately to the injured parts. The exact size and shape having been previously ascertained and determined, the gutta-percha should be cut accordingly, and then immersed in water heated to just below boiling-point. In the course of a very few minutes it becomes soft and perfectly pliant. It should then be removed from the water, and pressed for a moment between the folds of a dry towel. In this state, moderately dry and deprived of superfluous heat, it is to be put on the surface intended for support, and bound thereto by a roller. In the case of the jaw, the "four-tailed" bandage is of use in attaching the parts firmly to the head. The common causes of failure in the making of gutta-percha splints arise from the following circumstances. First, the water is not hot enough; secondly, the accessory appliances are not quite ready at hand; and thirdly, the Surgeon is not quick enough. The whole proceeding should occupy a very brief space. Unless the gutta-percha is properly heated, it does not adapt itself, and the support which it affords is imperfect. A preparation of vulcanised india-rubber, now much used by dentists for the construction of artificial palates, &c., is also applicable for the purpose now before us. Cardboard, leather, or even the four-tailed calico bandage stiffened with starch, may be employed when other materials cannot be obtained.

When the injury has been considerable, as in the case of a gunshot wound, it may happen that no apparatus can be applied; union will go on equally well under a soft bread-and-water poultice, often renewed. The condition of the parts is such as to guarantee from the patient himself most perfect rest. The practice of tying the teeth together was known to Hippocrates. Cases occur in which it may be employed with some advantage; and then the Surgeon should use the metallic in preference to the silken ligature, inasmuch as the latter is more apt to cut through the enamel of the teeth and to induce caries. When the teeth in the upper jaw are perfect, and can be applied to a set similarly perfect in the lower jaw, they serve as a useful splint, exerting counter-pressure to that caused by the gutta-percha.

The process of repair is not by provisional callus. A connecting material is poured forth from the vessels of the bone, in which ossification goes on in the usual way; the torn gum heals; teeth which have been only loosened regain their normal firmness; and the repair is usually perfect.

In cases of fracture about the ramus, condyle, or coronoid process, no more can be done than to keep the jaw quiet by means of the four-tailed bandage, either with or without any other splint, for the usually prescribed period. In the first situation, the masseter and internal pterygoid muscles prevent much displacement; in the second and third, the injured parts are beyond our reach. The detached condyle will be pulled forwards and inwards by the external pterygoid muscles, towards the base of the skull, near the foramen ovale, as described in the cases already recorded. The coronoid process may suffer some displacement by the action of the temporal muscle, but this may be inconsiderable, in consequence of the great extent of the insertion of the muscle, which reaches near to the last molar tooth. In all these cases an examination by the mouth may assist in our diagnosis.

Mr. James Salter, of Guy's Hospital, has adopted a useful mode of treatment in cases of fracture of the upper jaw. He prepares a gold plate to fit the interior of the mouth, so as to hold the displaced portions of bone as much as possible in position, thus far acting in every sense as a splint; but with the additional advantage that it is capable of repeated alterations from time to time, so as to force outwards inwardly projecting bone and teeth, as the patient can bear the pressure. He first takes an accurate model of the mouth, and upon this the plate or splint, whichever it may be called, is constructed, embracing some of the firm teeth. The plate is so framed as to exercise pressure only on the bone and teeth which are displaced. The beneficial effect was proved in an interesting case recorded in the *Lancet* (June 16, 1860, No. xxiv. vol. i.). A young gentleman, while playing at cricket, rushed forward with great impetuosity to catch the ball, when one of his companions, not perceiving him, and running forwards with a similar object, came into collision with him, and struck him a violent blow with his forehead on the upper jaw, immediately below the malar bone. There ensued a fracture of the maxilla, driving inwards the two right upper premolar teeth and the first molar, with their alveoli. The patient, by means of pressure gently maintained by the above-described splint, recovered completely in about six weeks; the displaced bone and teeth resuming their normal position.

Mr. Salter believes that the same principle may be maintained in fractures of the lower jaw. Any displacement that accompanies fracture of the superior maxilla is simply a passive condition; there are no muscles attached to the upper jaw, which can derange or draw out of place the broken bone. With the lower jaw, however, the case is very different; the inferior maxilla is a floating bone, to which many powerful muscles are attached, and those connected with the rotating movement of the jaw—namely, the pterygoids—have a strong lateral antagonistic action. Destroy the integrity of the maxillary arch by fracture, and that antagonism ceases; the muscles on either side act independently, and draw the points to which they are attached more or less to the mesial line, and this it is which causes the overlapping of the fractured ends of the bone, often so obstinate. A plate or splint (for the lower jaw, Mr. Salter prefers an ivory one), carved to fit the interior of the arch of the particular jaw, with small crescentic excavations for the existing teeth, when placed in the mouth, restores the integrity of the arch for the time being. It may be worn without inconvenience long enough to allow osseous union of the fractured ends, preventing displacement the while.

It is asserted that in rabid horses fracture of the jaw occurs from muscular cramp alone.

The separation of splinters of bone, the treatment of abscesses, of necrosis, and other accidents common to fractures in general, must be conducted on the general principles of Surgery.

Dislocations of the jaw. The articulation of the lower jaw is the only one which allows the head of the bone to escape from the articular cavity; the molar teeth of the upper and lower jaws are separated in mastication, by the sliding forward of the condyles of the latter upon the eminentiæ articulares, while the adaptation of the bony surfaces is completed by the inter-articular cartilage and its synovial membranes. The lower jaw slides forward upon the eminentiæ articulares in the act of masticating, of yawning, of laughing; and it is in one of these conditions in general that dislocation of the condyles under the zygomatic arch ensues, by the combined action of the masseters and internal pterygoid muscles. The temporal muscle drags the dislocated bone upwards.

The only direction in which this dislocation can happen is forwards. That in the backward direction is impossible, unless the osseous structure of the external ear is broken at the same time. Behind the condyle of the jaw lies a portion of the parotid gland and the mastoid process of the temporal bone. But displacement of either one or both condyles forward is of occasional occurrence. When recent, these accidents are attended with much pain. The mouth is open, and cannot be shut: an empty space is felt before the ear in the natural situation of the condyles. The coronoid process may be felt through the cheek, or within the mouth, and there may be some flattening of the cheeks and temples. The saliva flows in great quantity. The relation of the teeth is altered. When only one condyle is dislocated, the incisor teeth incline to the right or left side; and this fact can be readily ascertained by careful examination. After a time these symptoms, if the dislocation be not reduced, are not so well marked; the patient gradually regains the power of articulation and of swallowing, and can retain the saliva; but the sense of great discomfort remains for a long time.

Hippocrates declared the accident mortal, if not reduced before the tenth day; but this is clearly an error. I have seen a patient four months after the accident, with dislocation of both condyles into the zygomatic fossæ. The patient had suffered and was still bearing much pain, but the symptoms were becoming more endurable and the deformity was less apparent: an attempt to reduce the dislocation failed. In endeavouring to reduce a dislocation of the jaw, the Surgeon cannot do better than follow the old rule, when the accident is recent: "Let him wrap some linen round his thumbs, to keep them from being hurt by the patient's teeth, and then introduce them into the mouth, as far as possible along the grinding teeth; at the same time he is to place his fingers under the chin and the base of the jaw, and while he depresses the molars with his thumbs, he raises the chin with his fingers, by which means the condyles become disengaged from their situation under the zygoma; at which instant the muscles draw those parts so rapidly back into the articular cavities again, that the Surgeon's thumbs might sometimes be hurt did he not immediately move them outward between the cheek and the jaw."*

In the present day we use chloroform in difficult cases, and have recourse to what Mr. Samuel Cooper calls the practice "of the ancients," namely, the insertion of two pieces of stick between the molar teeth, to be used as levers to depress the angles of the jaw, while the chin is raised by the hand or by a bandage. But even with this plan, usually successful, I have witnessed failures, and have myself failed to move the jaw in a case of old luxation, where the parts had adapted themselves to their new position. All dislocations of the jaw, from accident, should be reduced without delay.

HOLMES COOTE.

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* *Cooper's Surgical Dictionary*, p. 390, 1830.

INJURIES OF THE NECK.

Wounds.

WOUNDS of the neck are generally made by the hand of the suicide or murderer; more rarely they are the result of accident. They differ much in their situation and extent, and the parts injured vary somewhat according to the position of the head and neck at the time the injury is received, and according to the direction and extent of the wound. Wounds at the back of the neck are generally far less dangerous to life than those inflicted in front; they not unfrequently produce, however, a palsied condition and wasting of the limbs: and wasting of the testicle, with loss of the generative power, is said by Chelius* to have been observed in these cases. If the wound is inflicted at the upper part of the neck, it may penetrate in the interval between the occipital bone and atlas, or between the atlas and axis, and injure the spinal cord.

Wounds of the front of the neck are made at some point between the lower jaw and upper border of the sternum. If made high in the neck, they are seldom of sufficient depth to implicate the larger vessels which lie at a point corresponding to the angle of the jaw. If the wound is lower down, opposite the larynx, the resistance offered by the cartilages generally prevents it from extending deep enough to implicate the larger vessels, more especially as the position of the head and neck at the time the injury is received renders them less liable to be wounded, from the larynx being thrown prominently forwards. Porter† remarks on this point: "When an unfortunate being lifts a razor against his own life, he throws back his head as far as possible, in order to expose his neck to the blow, and probably to bring the windpipe forward, as he imagines that wounds of this organ must be fatal. This position changes the relative situation of all the parts in the neighbourhood of which he is about to strike." A deep wound across the throat below the larnyx, or at the side of the neck, is more likely to implicate the larger vessels and nerves. Suicidal wounds of the throat are usually incised, with jagged edges, and vary in extent from a superficial abrasion, to one or several deep gashes implicating all the soft parts down to the spinal column. Occasionally, a penknife, or other pointed instrument, is thrust into some part of the neck, wounding, in some cases, the larger vessels, dividing the trachea and œsophagus, or penetrating the cavity of the larynx. These wounds appear to be more common in men advanced in life. In twenty-five cases admitted into St. George's Hospital, during the last twenty years, which terminated fatally, five occurred in females, varying in age from eleven to fifty-two, and twenty in males, the chief proportion in whom occurred between forty and sixty years of age. The main cause in the great proportion of cases is habitual intoxication; but in a few cases great privation, mental depression, bodily suffering, delusion, or fear, are the causes assigned. This serves to explain the reason of the great mortality noticed in suicidal wounds of the throat, the unfortunate sufferer being either in a state of delirium consequent on habitual intemperance occurring previous to, or soon after, the receipt of the wound, or in such a state of mental despondency as to operate most prejudicially on the bodily powers. In the twenty-five cases above alluded to, the wound was situated between the jaw and the hyoid bone in three; in five between the hyoid bone and the thyroid cartilage; in fifteen in front of or implicating the larynx; in one in the trachea; in one below the cricoid cartilage, implicating the soft parts only.

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* *Chelius's Surgery*, translated by South, p. 437.

† *On the Surgical Pathology of the Larynx and Trachea*, London, 1837, p. 242.

Wounds of the neck between the lower border of the jaw and the hyoid bone are less dangerous than in any other situation, for the larynx is less exposed to injury, there is no risk of hæmorrhage into the trachea, and the carotid vessels are not likely to be implicated, on account of their deep position at the side of the neck: a deep wound in this part of the neck, besides dividing all the depressor muscles of the jaw, may involve the lingual and facial vessels, or the submaxillary gland, or may even penetrate deep enough to sever the tongue from its connexions with the epiglottis. Such wounds are liable to prove fatal from great hæmorrhage, especially if the patient is a long time undiscovered after the receipt of the injury.

Wounds of the neck inflicted between the os hyoides and thyroid cartilage are more dangerous than the preceding, as the structures surrounding the upper aperture of the larynx are liable to be implicated. Even comparatively superficial wounds are occasionally attended with fatal hæmorrhage from division of the superior thyroid or lingual vessels; and a deep wound would cut through the thyro-hyoid membrane, opening the anterior wall of the pharynx. It might also divide the epiglottis, the mucous folds surrounding the upper aperture of the larynx, and occasionally the arytænoid cartilages or vocal cords. The extent to which any of these parts is implicated may generally be determined by the situation, extent, and depth of the wound. The nearer the latter approximates to the upper border of the thyroid cartilage, the greater is the risk of the upper part of the larynx being interfered with. The epiglottis is frequently injured in wounds made in this situation. In a case of cut-throat recorded by Mr. Houston,* in which the wound had been made between the hyoid bone and thyroid cartilage, the epiglottis, loosened from its upper and lateral attachments, was left hanging by its pedicle to the back of the pomum Adami, and fell over the rima glottidis, obstructing respiration so completely that, within a few minutes after the accident, symptoms of suffocation ensued. The epiglottis having been raised, was brought over the edge of the thyroid cartilage, and secured by a single stitch to its anterior surface; respiration then returned, and the man in a short time sat up and attempted to speak, but was unable to articulate. He died in about a week after from erysipelatous inflammation of the neck and throat. More frequently the epiglottis is divided transversely, the anterior wall of the pharynx and the upper orifice of the larynx being opened into. Under such circumstances, especially if the wound gapes widely, any nutriment taken into the mouth, partially or wholly escapes by the wound; and great difficulty is frequently experienced in deglutition on account of the convulsive cough, and irritation of the larynx, produced by the food in its passage across the imperfectly protected laryngeal orifice. Wounds in this situation are sometimes followed in the course of a few hours, in other cases at a later period, by great difficulty in breathing, spasmodic fits of suffocation, complete loss of voice, and lividity of the face; and unless relieved by appropriate antiphlogistic treatment, and the early performance of the operation of laryngotomy, the patient soon dies; for such symptoms indicate the existence of inflammation and œdema of the glottis, and of the mucous membrane surrounding the upper aperture of the larynx.

A wound of the laryngeal part of the air-passage is always dangerous to life, as the injury may be complicated with hæmorrhage into the trachea, or the glottis may become occluded, either from the detachment of a portion of one of the normal structures of the part filling up the aperture and acting as a foreign body, or from emphysema of the submucous cellular tissue of the larynx, or from inflammation and œdema of the glottis, with extension of inflammation along the trachea and bronchi to the lungs. At a more remote period, impeded respiration may arise from an exuberant growth of granulations and thickening of the mucous membrane in the neighbourhood of the wound.

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* *Dublin Hospital Reports*, vol. v. p. 315, cited by Ryland.

In some cases the soft parts in front of the thyroid cartilage are divided by one or more jagged wounds, but without the cartilage itself being implicated, or the larynx subsequently affected. In other cases the thyroid cartilage is divided across by one or more deep gashes, the wound occasionally penetrating the mucous membrane of the larynx. In all cases of the latter kind, whether the mucous membrane is injured or not, great danger of inflammation and œdema of the glottis is to be apprehended, although this does not invariably occur. Wounds of the larynx may also prove fatal, by causing such an amount of local emphysema as to impede respiration.

A wound of the upper part of the thyroid cartilage may involve the arytænoid cartilages, a remarkable case of which is mentioned by Sir C. Bell.* A man, who had cut his throat, suffered occasionally from great difficulty of breathing, accompanied by a flapping sound in the throat. After death, it was found that one of the arytænoid cartilages had been divided, and it hung by a membrane, so as to vibrate in the chink of the glottis, like a pea in a cat-call; and, acting as a foreign body in the rima glottidis, produced suffocation. Punctured wounds of the thyroid cartilage occasionally penetrate the larynx, between the vocal cords: in such cases œdema of the glottis almost invariably occurs, producing death by suffocation; and Sir C. Bell† has mentioned an instance in which a young woman, who had inflicted a wound in this situation by a penknife, was suffocated some months afterwards by the exuberance of the granulations which arose from the edges of the wound, and which filled up the aperture of the glottis. In those cases where the glottis, or any part of the cavity of the larynx above it, is occluded, respiration will be at first impeded, and afterwards entirely obstructed; and the only remedy by which the patient has a chance of recovery, or of prolonging life, is the early performance of laryngotomy. When the cartilages of the larynx are entirely divided across,—an injury, however, of rare occurrence,—the upper portion of them is drawn upwards by the elevator muscles of the larynx, and the lower portion is drawn downwards by the depressor muscles, producing a large gaping wound, which is usually complicated with a wound of the anterior wall of the pharynx.

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* *Surgical Observations,* vol. i. p. 44.

† Ibid. vol. i. p. 45.

The trachea is not unfrequently divided in wounds of the neck; if partially cut across in a transverse direction, the edges of the wound separate only very slightly from each other, and are easily retained in contact, by flexing the head and neck upon the chest, and retaining them in that position. Sometimes it is completely divided; under these circumstances the two ends of the tube separate considerably from each other, the lower end retracting under the neighbouring parts, in consequence of which respiration is performed with great difficulty. Such extensive wounds of the trachea are usually, but not always, fatal, from being complicated with wounds of the œsophagus, and with division of the large vessels and nerves. But cases are recorded by surgical writers, in which the trachea has been completely cut across, and the œsophagus opened, without any wound of the carotids.* Wounds of the larynx or trachea, if extensive, are always attended with complete loss of voice, from the air, during expiration, passing through the wound, instead of through the larynx; but the voice may, to a certain extent, be restored, by bending the head forward, when the edges of the wound are partially approximated, so that the escape of air through it is prevented. The air then takes its natural course through the larynx, and a feeble voice will be heard.

When a wound in the neck is inflicted in the thyro-hyoid space, the pharynx is much more likely to be injured than if the wound is made in front of the most prominent part of the laryngeal cartilages, as these must be divided completely across before the pharynx is opened into. In complete transverse division of the trachea, the œsophagus rarely altogether escapes, the latter tube being partially divided or completely severed. Wounds of the œsophagus, in the case of extensive wounds of the throat, may be known by examination with the finger, and also by the escape of fluids, or other matters, swallowed by the patient, through the wound. This latter symptom *alone*, however, is no proof that the œsophagus or pharynx has been opened into, as several cases have been recorded in which the escape of ingesta through a wound in the throat has been unaccompanied with any injury to the gullet. It seems probable that, in these cases, there was some deficiency in the action of the epiglottis, the result of inflammatory thickening, injury to its structure, or to the nerves which supply it; and that the source of the matters which escaped by the wound may be traced to their passage along the trachea.

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* *Edinburgh Medical and Surgical Journal,* vol. xvi. p. 353.

Wounds of the throat which divide completely both trachea and œsophagus are generally attended with great danger to life; for if the patient escapes death from hæmorrhage, retraction of the lower ends of both of these tubes takes place to such an extent, that respiration is seriously interfered with, and suffocation is almost inevitable: but cases, even of this kind, have been recorded, in which complete recovery was effected. Dr. Gairdner* records the case of a man who cut his throat with a razor, dividing the larynx at the upper part of the cricoid cartilage, and the œsophagus also; the cut extremities receding from each other to the distance of at least three inches: attempts were made to unite the divided larynx by means of sutures, and to pass a gum elastic catheter from the nostril into the œsophagus, but without success. Ultimately the man recovered, with an aperture in the front of the neck, through which respiration was performed, and through which liquid nourishment was conveyed into the stomach, by means of an elastic tube, introduced at each meal into the lower portion of the œsophagus. Two years after the infliction of the wound this patient was strong and fat, and had all the appearance of a person enjoying excellent health.†

Treatment. When called upon to attend a case of wound of the neck, the Surgeon's first duty is to *arrest hæmorrhage.* This may be effected by applying ligatures to any divided arteries, and by pressure with the finger, if the hæmorrhage is venous. If the external jugular vein is wounded, and the hæmorrhage from it considerable, it may generally be stopped by slight but continued pressure with the finger, beneath which a small pad of lint is placed.‡ If the internal jugular vein is wounded, the hæmorrhage is profuse, and very rapidly fatal, unless prompt assistance is afforded. Mr. Bryant has recorded, in the *Pathological Transactions of London*, vol. viii. p. 101, the case of a little girl, nine years of age, who, whilst carrying a chamber utensil in her hand, stumbled, and fell on the broken china, producing a wound of the right internal jugular vein, from which followed such profuse hæmorrhage that she died, five minutes after her admission into Guy's Hospital. In cases of this kind, where the hæmorrhage is venous, and it is evident from the situation of the wound that some large vein is injured, the wound should be immediately plugged with small pieces of sponge, and pressure with the finger applied as long as necessary. A man was admitted into St. George's Hospital on July 14, 1847, having cut his throat with a penknife, which was followed by profuse hæmorrhage. On the left side of the neck, a little below the cricoid cartilage, was a wound about an inch and a half in length, extending transversely across the space between the sterno-mastoid and trachea, partially dividing the muscles in this situation, and passing for some distance under the skin towards the clavicle. Dark blood was still welling from the wound, which was plugged with sponges, and pressure with the fingers applied. At 1 P.M. the wound was dilated upwards and downwards, no bleeding vessel was discovered, and it was evident that the bleeding proceeded from the lower end of the wound. About half a pint of blood was lost before the sponges were reapplied. The wound gradually suppurated, and the last sponge had been removed when a deep granulating cavity was seen, with a slough in the direction of the sheath of the vessels. On July 22, at 5 P.M., the hæmorrhage suddenly recurred to an alarming extent, and the patient died in the evening. On inspection of the body, a slough, completely destroying the front wall of the internal jugular vein for three inches of its extent, was found. The sloughing extended from about an inch above the junction of this vein with the subclavian, upwards; the posterior half of the vessel alone remaining. The common carotid artery had also been wounded at its anterior part; the opening was small, and was blocked up by lymph and coagulum, which was intimately adherent to the edges of the wound.* In wounds of the carotid artery and its branches, the most prompt measures are necessary, and medical assistance is too often sought for after the necessity for it exists.

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* *Ed. Med. and Surg. Journal*, vol. xvi.

† Hennen's *Military Surgery*, p. 368, 3d ed. 1829; case communicated by Dr. James Johnson. A Malay cut his comrade's throat while asleep; the larynx was divided, and also half of the œsophagus: he was supported by enemas, and gradually recovered.

‡ A remarkable case of sudden death from division of the external jugular vein is recorded in the *Boston Medical Magazine*, vol. iii. p. 117. The patient lost a pint of blood. It is suggested that death may have arisen from the entrance of air into the vein.

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* A case in which the internal jugular vein was partially divided with a razor, and the patient saved by securing it with a ligature, is given by Dr. Morgan of Geneva, in the *American Journal of the Medical Sciences*, vol. xviii. p. 330. He refers to two other successful cases of ligature of

During the summer of 1859, one of the inmates of St. George's Hospital committed suicide by cutting her throat. She was almost immediately seen by the House Surgeon, but had already ceased to breathe, and was quite pulseless. There was a deep gash in the throat, dividing the left common carotid artery, and wounding both internal jugular veins. If, in a wound of the throat with free arterial bleeding, the Surgeon should arrive before the patient is dead, pressure should be at once applied over the wound; then the wound may be enlarged, and the wounded vessel, if found, secured; or, in the event of such vessel not being found, a ligature should be applied to the common carotid.* In lacerated wounds involving the carotid artery, the patient does not always immediately bleed to death, for it is the nature of wounds of this kind to bleed less freely than incised wounds. Abernethy has related a case in which the internal carotid, and all the branches in front of the external carotid, were wounded in a man who was gored in the neck with a cow's horn; yet death did not directly follow, and there was time to have recourse to the ligature.†

When all bleeding has ceased, but never until then, measures should be adopted to approximate the edges of the wound. If the wound is superficial, dividing merely the skin and superficial muscles, the edges may be united by adhesive plaster, union being assisted by attending carefully to the position of the head, bending it forwards in transverse wounds of the neck, and keeping it extended in longitudinal ones. Simple transverse wounds of the neck, through the thyro-hyoid space, or partially dividing the larynx or trachea, should always be approximated by position alone; no plasters or sutures should on any account be used, except in a few cases to be hereafter mentioned; for these wounds, especially if suicidal, rarely unite by primary adhesion; so that sutures, for this reason alone, are quite unnecessary. But many dangers may be avoided by keeping the

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this vessel, by Dr. Stevens of New York, and Dr. Gibson of Philadelphia. For particulars of the latter case see *Amer. Journal Med. Sciences*, vol. xiii. No. 26, p. 305.

* Vide *Med.-Chir. Trans.* vol. xxx. p. 15; case by Mr. Le Gros Clark. Other instances of a divided carotid not proving fatal are recorded by Baron Larrey, in *Lond. Med. Gaz.* vol. viii. p. 250.

† *Surgical Works*, vol. ii.

parts in simple apposition. If all bleeding has not ceased, and the wound is united, the blood, instead of escaping externally, may trickle into the air-passage, and, accumulating there, suffocate the patient; and this is especially liable to occur during the insensibility of the patient from loss of blood, and from his inability, through faintness, to make the necessary efforts to expectorate it. Inflammation and œdema of the neighbouring parts, and of the lining membrane of the larynx or trachea, may take place to such an extent as to seriously interfere with respiration; and this is always rendered more hazardous from the quantity of viscid mucus which, under such circumstances, is collected in the air-passages; the risk of impeded respiration being greatly lessened if the wound is left ununited. Again, union of the wound by sutures is liable to be followed by emphysema, from air escaping out of the trachea or larynx into the cellular tissue. Under all circumstances, then, the risk of impeded respiration is much lessened by leaving the wound open. The patient should be placed in bed in a moderately warm room, the shoulders well raised by pillows, and the head bent forwards, and retained in that position by a bandage passing from each side of the nightcap to a roller which has been previously passed round the chest, and the wound should be covered with a strip of wet lint or linen. A skilful nurse should be kept constantly at the bedside of the patient, to prevent any renewal of the attempt at suicide, and to clear the wound of any mucus or blood that may from time to time collect in it. If the patient finds great difficulty in expectorating, it may be rendered easier by closing the wound with the finger at the time the effort is made. Every means should be adopted to favour granulation and cicatrisation of the wound; care should be taken to allay all symptoms indicating incipient inflammation of the larynx or trachea; bronchitis is indeed one of the most common consequences of injuries of this kind, and is probably excited by the direct access of cold air to the bronchial membrane; if this is unrelieved at its commencement, it is soon followed by inflammation of the lungs and pleuræ. But the most unfavourable symptoms which the Surgeon has to contend with in these cases are the low muttering or furious delirium, consequent on the habits of intemperance, which too often accompany suicidal wounds of the throat, or the mental despondency which, in other cases, has led to the commission of the act, and which continues afterwards to exercise its pernicious influence on the system. These latter symptoms exert a far more injurious influence on the patient than almost any produced from the effect of the wound; too often, indeed, the most trifling injury committed under such circumstances, accompanied by corresponding symptoms, leads to the speedy death of the patient. As a general rule, the patient should not be kept too low; generous living, wine, and spirit, may be given as circumstances show their necessity, care being taken, however, not to stimulate so much as to excite inflammation.

There are some cases of wound of the larynx or trachea in which sutures are justifiable. Thus, if the cartilages of the larynx are cut in several places, and the different pieces much separated from each other, they may be joined together by one or more sutures passed through the cellular tissue surrounding them. If complete division has been effected between the thyroid and cricoid cartilages, and these parts are separated from each other, one or two sutures may be used to keep the parts in better apposition. And if the trachea is completely divided across, it may be necessary in some cases to have recourse to one or more sutures. In each of these cases it is better to try the effect of position first, because, if the divided parts have not separated from each other to any great extent, a sufficient approximation of the cut edges may be accomplished without having recourse to sutures; but if sutures are used, and respiration should become obstructed, or if the cellular tissue around the wound becomes emphysematous, they must be instantly divided, and recourse had to position alone.

The respiration should be carefully watched in these cases, as difficulty of breathing may arise from various causes, and should be at once relieved. Thus the epiglottis, one of the arytænoid cartilages, or a portion of one of the cartilages of the larynx or trachea, may be so detached as to seriously obstruct respiration; or, in complete division of the windpipe, any movement may be accompanied by one end of the tube being displaced and overlapping the other; or blood may collect in the trachea or in the cellular tissue external to this tube; hæmorrhage coming on after the wound is dressed, on the establishment of reaction, or at a later period from the effects of ulceration. Acute inflammation of the larynx and trachea may occur soon after the injury, especially if the edges of the wound are tightly brought together; or, at a later period, obstructed respiration may arise from chronic thickening of the tracheal mucous membrane, and the formation of granulations in the neighbourhood of the wound. If, in any of these cases, suffocation threatens, and is not relieved by enlarging the wound, the air-passage should be opened below the wounded part, and a canula retained in it. Then the edges of the wound in the throat may be approximated, as no risk exists of suffocation being induced. Indeed, some Surgeons consider that in extensive transverse wounds of the throat involving the trachea, in whatever manner they are inflicted, tracheotomy may be performed with advantage as soon as all hæmorrhage has ceased, and the patient has recovered from the shock of the injury. The edges of the wound may then be approximated without any risk of suffocation, the canula being removed when the wound is united, and the opening in the trachea then closed. Obstruction to respiration may arise some time after the healing of the wound in the trachea or larynx, from contraction of their canals, and more especially if a fistulous opening has been for some time established, in consequence of the wound being imperfectly closed. In cases of this kind the contracted passage may be dilated by bougies passed from the mouth; and when restoration of the normal size of the larynx or trachea is effected, the margins of the fistulous opening should be pared, the edges approximated, and union secured.

When the pharynx or œsophagus is laid open, or when the latter tube is completely divided, great separation of the edges of the wound always takes place during the act of swallowing, and the ingesta partially escape through the wound, and prevent its union. To remedy this, the elastic tube of a stomach-pump, or a common elastic catheter of large size, should be used to convey nourishment to the stomach. It should be introduced from the mouth, and passed into the œsophagus a little below the wound. It may be used two or three times daily, or even more frequently if circumstances require it. The tube should on no account be passed through the wound; otherwise union is very seriously interfered with. Before any fluid nourishment is introduced through it, care should be taken to ascertain that the tube has not been passed into the trachea. This may be ascertained by placing a lighted taper at the end of the tube, and observing if the flame is interfered with during expiration. It sometimes happens that the introduction of the tube is very distressing to the patient, and produces much irritation in the wound; under these circumstances the patient must be supported by nutrient enemata.

Wounds of the larynx and trachea are sometimes, but very rarely, followed by incomplete union, a fistulous opening remaining after the rest of the wound has closed. Through this opening the patient breathes, and occasionally expels mucus by coughing, and the voice is very indistinct unless the aperture is closed by the finger. In such cases, an attempt should be made to close the opening, by paring the edges of the fistula, and endeavouring to unite them by the twisted suture; or a piece of skin may be raised from the surface of the neck above the opening, and united to the edges of the wound.

Other injuries of the pharynx and œsophagus. Besides the injuries of the pharynx and œsophagus above spoken of, which are complicated with division of the trachea or larynx, and usually also of the larger vessels and nerves, either of these parts may be wounded by sharp-pointed instruments, or other foreign substances thrust from within the mouth.

If in an injury of this kind the side of the pharynx is wounded, dangerous, or even fatal, consequences may arise from wound of the larger vessels. The following case will serve to illustrate this form of injury, and the treatment necessary to be adopted under similar circumstances.

A boy, æt. seven, was admitted into St. George's Hospital, May 12th, 1850. A week before his admission, he fell whilst holding the sharp end of a parasol in his mouth. The point was forcibly thrust to the back of the fauces, and very nearly made its reappearance through the skin at the side of the neck. Considerable hæmorrhage took place at the time of the accident, and recurred on the same night. About the seventh or eighth day, a slough came away from the interior of the mouth, and hæmorrhage of arterial blood took place to the amount of about five ounces. This hæmorrhage was stopped by pressure applied externally, and the boy was soon afterwards brought to the hospital. On examination, a swelling about as large as half a hen's egg was found below and a little behind the left ear, and the skin for some distance around was discoloured, as from extravasation of blood. Fluctuation was detected on the summit of the swelling. This being opened, pus with much blood-clot escaped, but no hæmorrhage ensued. Two days afterwards, a gush of arterial blood followed a fit of coughing, when Mr. H. C. Johnson cut down upon and tied the common carotid artery of the corresponding side. No unfavourable consequences ensued from this operation. Nine days afterwards, the ligature was found loose; it soon came off entirely; the wound healed, and on June 12th, twenty-seven days after the tying of the vessel, the child was discharged in a very favourable state.

Chelius observes, that "wounds of the œsophagus, if there be no accompanying severe injury, often heal without any symptoms."

Dangerous consequences may, however, ensue if a wound of this tube is accompanied with severe injury of neighbouring parts, as is shown in the following case, related by Dr. Parkes.* A young, healthy, athletic juggler, on the evening of January 24th, was exhibiting the trick of swallowing a sword. The sword was made of a piece of iron about two feet long, three-quarters of an inch broad, round and blunt at the end. When passed to nearly the root of the neck, he felt it strike against some obstacle; he therefore pushed the sword violently past the obstacle. Immediately afterwards he withdrew the sword, gave a sudden leap into the air, then fell and fainted. When he recovered, he vomited violently, the vomited matters consisting of the contents of the stomach, without the slightest tinge of blood. Intense pericarditis, marked by its characteristic symptoms, came on forty minutes after the accident, and he died in the evening of the second day following the injury. Five and a half inches from the lower border of the pharynx, the sword had struck on the anterior wall of the œsophagus, and had torn an opening about an inch in length and several lines broad. All the coats of the œsophagus were penetrated, and the instrument had passed into the pericardium. An immense quantity of lymph was effused over the whole parietal and visceral pericardium; all the important vessels and organs in the neighbourhood were uninjured.

OTHER INJURIES OF THE AIR-PASSAGES.

Contusion of the larynx. A blow upon the larynx may be suddenly fatal by arresting respiration, the rima glottidis being either partially or entirely closed by spasm of its muscles. Under these circumstances, the operation of laryngotomy should be at once performed, and a tube retained within the larynx until the functions of this organ are restored.† Sometimes the symptoms which follow a blow upon the larynx are less severe, and may be subdued without having recourse to any operative measures. A woman between fifty and sixty years of age came lately under my care, who had fallen down and struck the larynx violently against the edge of a fender: when I saw her, two days after the accident, her voice was nearly inaudible, great pain was complained of in the region of the larynx, and some swelling existed in its immediate neighbourhood. There was no difficulty in respiration. Leeches were applied to the throat, and mercury in small doses was administered. The symptoms were relieved, but swelling of the part still remained, and pain was complained of for some time afterwards, whenever an examination of the part was made. These symptoms subsided altogether by the application of counter-irritants to the nape of the neck and upper part of the sternum, and by the exhibition of small but frequently-repeated doses of the bichloride of mercury.

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* *Path. Trans. London*, 1848-9, p. 40.

† Vide a case by the late Robert Liston, Esq., in the *Ed. Med. and Surg. Journal*, vol. xix. p. 570.

Fracture of the hyoid bone. Fracture of the hyoid bone is a rare accident, and is usually caused by direct violence, such as a blow or fall upon the neck. In criminals executed by hanging, fracture of this bone is occasionally, but not invariably, found. One or both cornua are the parts usually injured, sometimes the body; much displacement of the fragments generally occurs. The patient complains of pain in the neck, inability to turn the head, great difficulty, or sometimes total inability, to swallow. The voice is hoarse, the patient having great difficulty and pain in speaking, and there are occasionally symptoms of suffocation. On examining the throat externally, crepitus or some irregularity may be detected, and on looking into the mouth, there is not unfrequently some ecchymosis and swelling of the mucous membrane in the region of the tongue, the fragments occasionally perforating the mucous membrane.

Dr. Gibb kindly furnished me with a reference to the following case, described by Dr. Lalesque,[*] in which the hyoid bone was broken, in a marine, æt. 67, who had had his throat violently clenched in a quarrel. At the moment there was very acute pain, and the sensation of a solid body breaking. The pain was aggravated by every effort to speak, to swallow, or to move the tongue; deglutition was impossible, articulation indistinct, and he was unable to open his mouth without a great deal of pain. The left horn was broken near the body of the bone, and had pierced the mucous membrane, giving rise to considerable hæmorrhage. He was fed by an œsophagus-tube for twenty-five days, and ultimately recovered.

The treatment consists in restoring the displaced fragments to their proper position, by passing the finger of one hand into the throat, the other hand fixing the bone externally. Inflammation must be relieved by the application of leeches to the throat. The patient should be kept quiet, every attempt at speech avoided, and antiphlogistic regimen adopted. If difficulty of breathing should supervene, laryngotomy must be performed; and if the patient cannot swallow, or finds great difficulty and pain in doing so, the use of the stomach-pump is requisite. If the passage of this tube produces much pain or inconvenience, the patient must be supported by nutrient enemata. Cases, however, have occurred in which detection of the fracture was more difficult than it is usually considered. A labourer, aged 63, fell from a wagon on his face, and discharged a large quantity of blood by the mouth. He found himself unable to swallow, complained of severe pain in the neck, with inability to turn his head, his voice was hoarse and difficult, and on attempting to drink, the fluid was rejected with violent coughing, the patient declaring he felt it as if entering the air-passages. The tongue was movable in all directions, and depressing it gave rise to no inconvenience. No crepitation, or unusual mobility was perceived about the hyoid bone, and there was no pain at the root of the tongue on attempting to swallow. Nothing unusual was detected on examining the fauces, but the epiglottis did not appear to completely close the larynx, or to be in its exact position. Medicine and food were administered by an elastic tube. The pain in the neck subsided, and its motions were restored, a hectic cough from which he had long suffered alone remaining; the cough increased, the voice became scarcely audible, and the patient died exhausted eleven days after the receipt of the accident. Fracture of the hyoid bone was found. One of the large cornua was broken, and had become firmly imbedded between the epiglottis and rima glottidis, inducing the raised position of the epiglottis, loss of voice, and difficulty in swallowing.*

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[*] *Journal Hebdomadaire*, March 1833; and *Am. Jour. Med. Sci. Phil.* vol. xiii. 1833, p. 250. Other similar cases are recorded by Auberge, in the *Revue Médicale* for July 1855, and in the 8th volume of the *Brit. and For. Med.-Chir. Review*, 1851.

Dislocation of the hyoid bone. Dr. Gibb has recorded† a case of dislocation of the hyoid bone, which occurred in a patient under his care, a man æt. 45. This patient "would feel a sudden click in the left side of his neck, which produced a sensation as if something was sticking in his throat. On examination, this appeared to depend upon a displacement of the left horn of the hyoid bone, and was generally reduced by throwing the head backwards, towards the right side, so as to stretch the muscles of the neck, and then suddenly depressing the lower jaw, and so putting the depressors of the hyoid bone into operation. He died some years after of pulmonary consumption. On examining his throat after death, a sort of pouch was found, which answered the purpose of a synovial capsule, embracing the horns of the thyro-hyoid articulation. It was filled with a clear fluid, had a comparatively large rhomboid sesamoid bone developed in its outer wall, and permitted an extraordinary amount of motion." This is the fourth case which had come under the notice of Dr. Gibb, all of which occurred in the male sex. It appears also, according to this author, that Dr. Ripley of South Carolina read before the Parisian Medical Society in 1848 a paper on " Dislocations of the Os Hyoides," occurring more particularly in his own person, and the manner of reducing them. The latter process consisted " in throwing the head backwards as far as possible, so as to place the muscles of the neck on the stretch, then relaxing the lower jaw, at the same time gently pressing or rubbing over the displaced part, when the dislocation becomes reduced after a few attempts with a cluck."

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* *Brit. and Foreign Med.-Chir. Review*, 1851, vol. viii. p. 549.

† *Trans. of the Path. Soc. London*, vol. x. p. 66.

Fracture of the cartilages of the larynx. The cartilages of the larynx are sometimes broken, the result of a blow or fall upon the front of the neck, or from a forcible squeeze of the throat; and the fragments may be displaced, so as to encroach upon the cavity of the larynx or pharynx, and occasionally perforate the mucous membrane. Injuries of this kind are of extreme danger to life, in consequence of respiration being obstructed, either immediately after the injury, from the displacement of the ends of the fracture; or subsequently, from very extensive local or general emphysema, or from inflammation and œdema of the lining membrane of the larynx.

The patient complains of pain in the injured part, there is ecchymosis and emphysema of the neck, if the fragments have perforated the lining membrane; and this emphysema may extend over the whole surface of the body. On examining the throat externally, fracture and displacement of the fragments may be felt. The voice is either much altered or entirely lost; the act of swallowing is attended with much pain and difficulty. Cough supervenes, probably accompanied with bloody expectoration; the respiration becomes noisy, snoring, and performed with much difficulty; symptoms of suffocation come on, and rapidly approach a fatal termination unless relief is afforded.

The main object in these cases is to afford relief to the obstructed respiration, by opening the larynx, and then to attempt by careful manipulation to restore the displaced fragments to their proper position. This may be effected by inserting a director or other instrument into the larnyx through the artificial opening, and carefully raising and readjusting the fragments; subsequent inflammation and œdema being relieved by appropriate antiphlogistic or other means.

But fracture of the laryngeal cartilages may occur without giving rise to any very marked symptoms, and without being attended with displacement or deformity; a case of which kind is recorded by Dr. Gibb.*

Rupture of the trachea. Partial or complete rupture of the trachea, from external injury, occasionally happens, and is generally fatal, on account of the very rapid and extensive emphysema which is produced. Dr. Berger† relates the case of a man who was kicked by a horse just below the lower jaw. There was hardly any wound, but the neck became much swollen; the breathing was greatly embarrassed, and general emphysema came on, the patient dying in an hour and a half. The trachea was found almost completely separated from the larynx, the various portions of the latter remaining uninjured. About a third of the connexion with the larynx remained; several rings of the trachea being torn through. The lungs were much loaded with blood, and the trachea was full of coagula.‡

I am indebted to my friend Dr. Britton Halford for calling my attention to the following case § of rupture of the trachea, recorded by Mr. Long, of the Liverpool Infirmary. It is a good instance of recovery from this formidable injury; it also serves to show the treatment that may be employed under similar circumstances, and the curative means adopted by nature in the healing of the wound.

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* Some instructive cases of fracture of the larynx may be found in the eighteenth volume of the *Edinburgh Medical and Surgical Journal*, and in the *British and Foreign Medical Review* for 1851.

† *Medical Times and Gazette*, 1856, p. 650; from the *Berlin Medicin. Zeitung*, No. 33.

‡ A fatal case of longitudinal rupture of the larynx and trachea by a kick is recorded by Dr. O'Brien in the *Edinburgh Medical and Surgical Journal*, vol. xviii. p. 412. Another case is recorded, which occurred in the neighbourhood of Glasgow, where the trachea was totally divided by violence. A boy, driving the gin of a coal-pit, placed himself on the end of the lever. On stretching out his head to look at something, his throat came in contact with a post. Such was the force with which he was going round, that the trachea was ruptured across. He survived for several days, but in great agony. *Beck's Med. Jurisprudence*, 7th ed., p. 718.

§ *Med. Times and Gazette*, July 26, 1856.

A railway labourer, æt. 20, while connecting two railway carriages, was caught round the neck by the coupling irons. When brought to the infirmary, there was some abrasion of the skin of the neck, slight tumefaction, and slight emphysema; he spoke in a subdued tone of voice; there was also partial paralysis of the arms. On first examination no laceration of the trachea was detected, but it was concluded from the nature of the accident, and from the emphysema, that such must be the case. In the evening of the same day, some difficulty of breathing took place, with considerable distension and pain in the neck. These symptoms came on at intervals during the five days following the accident, and became at last so urgent that an incision was made in the median line of the neck, over the site of the trachea, and the finger being introduced into the wound, among a mass of clotted blood, no trachea could be found. On turning out the blood, a bubble or two of air escaped from the lower part of the wound, just above the sternum. This was found to proceed from the lower end of the trachea, which was pushed aside, possibly by the effused blood. The finger being then passed upwards into the larynx, the lower end was found at least two inches distant from the separated trachea below. All connexion between the two was completely gone. The trachea was clogged with blood, which was repeatedly removed by suction; the patient each time experiencing considerable relief. A tube was introduced into the lower end of the trachea, and the man's head inclined downwards, so as to diminish the extent of the gap as much as possible. On Nov. 3d, nine days after the accident, the trachea-tube was removed, and a double piece of gauze placed over the opening; the wound becoming quite closed by December 1st. When Mr. Long examined the patient, about six months after the accident, he observed a depression to exist "in the throat, just above the sternum, capable of holding a walnut; which is increased doubly in depth and width during each inspiration. A fragment of trachea can be detected attached to the lower part of the larynx; below this nothing is felt like tracheal rings, but merely a fibrous tissue; his voice is hoarse, like that of a person suffering from the commencement of a cold; and when he breathes quickly and deeply, the sound produced is that of air passing through a narrow tube. I presume, therefore," says Mr. Long, "that a fibrous tube has been developed in the space existing between the upper and lower ends of the divided trachea."

Injury of the larynx from the inhalation of flame. Mr. Ryland, in his work upon the diseases of the larynx, appears to have first noticed the effects produced on the larynx from the inhalation of flame, or of intensely heated air; he describes the post-mortem appearances, observed in four cases, of this injury; and remarks "that the symptoms, during life, were those of severe bronchitis, without any of that peculiar dyspnœa that results from an obstructed condition of the laryngeal aperture." Injury of the larynx from the inhalation of flame, or of an intensely-heated atmosphere, is not an uncommon accident. Some part of the dress accidentally takes fire; the poor sufferer, in intense fright, rushes for assistance; this only accelerates the mischief, and the whole body becomes enveloped in flame, sometimes scorching the entire surface, leaving no part uninjured; more frequently injuring the upper extremities, head, neck, face, and lips; and occasionally injuring only the lower limbs and lower part of the trunk. In many cases, some part of the heated atmosphere surrounding the body is inhaled, producing that intense inflammation of the respiratory tract not unfrequently observed after extensive burns; and although this form of injury to the larynx is more frequent in those cases of burns in which the head, neck, and face are more especially implicated, it occasionally occurs in those in which the burn is limited to the lower limbs and lower part of the trunk. In twelve cases of inflammation of the larynx from the inhalation of flame, which have occurred at Saint George's Hospital during the last few years, nine were burnt severely about the neck and face; in three the burn was confined to the lower limbs and lower part of the trunk. In a few of these cases there was difficulty of respiration, almost from the time of the injury: in others, symptoms of dyspnœa came on, a few hours, or on the first or second day, following the injury; death occurring in the majority of cases on the first or second day, and in two cases as late as the eighth and ninth day. In those cases in which the burn had extensively injured the face and neck, and around which consequently there must have been a great accumulation of flame, symptoms of dyspnœa were noted to occur very early; but in the two cases in which death did not take place till a much later period, the burn had not implicated the face and neck, affecting merely the lower limbs and lower part of the trunk; and the symptoms of difficult respiration did not make their appearance till the second day after the injury, and at first only to a slight extent. In both of these cases, the affected parts were extensively and deeply injured; but it is proper to remark that they occurred in patients at a period of life when the constitutional powers are more capable of supporting the shock of such an injury than in children or the aged, the subjects of the other cases.

After death the mucous membrane of the mouth is found of a dark livid colour, or inflamed and œdematous; the tongue occasionally very injected; the mucous lining of the fauces, and occasionally that of the pharynx, of a bright scarlet hue. The vascularity ceases, usually, at the junction of the pharynx and œsophagus; but in one case it extended into this tube for about an inch; and in another case the whole length of the tube was of a dark livid colour. The mucous membrane of the epiglottis, and of the aryteno-epiglottidean folds, is of a bright scarlet hue, and the submucous cellular tissue of these parts œdematous; the mucous lining of the larynx and trachea is inflamed, and shreds of lymph are occasionally seen on its surface. The lining membrane of the bronchi is often inflamed, and the tubes loaded with thick yellow mucus. The pleuræ are rarely affected; but the lungs, in most cases, are either congested, sprinkled with patches of a vivid red colour, or in a more advanced condition of inflammation.

In very extensive burns, the detection of laryngeal inflammation may be sometimes difficult, on account of respiration being, under such circumstances, much accelerated. The treatment should in all cases be antiphlogistic, calomel being administered in small but frequent doses, as soon as croupy breathing shows the existence of inflammation of the larynx.

Injury of the larynx from drinking boiling water. Dr. Marshall Hall* first brought before the notice of the profession an account of an accident usually occurring to young children, and caused by their attempting to drink, by mistake, boiling water from the spout of a tea-kettle. It is not uncommon among the poorer classes in certain localities to have but a single vessel to use for culinary purposes, and this, probably, a large tea-kettle, which the children are accustomed to drink from, in order to allay their thirst. If the water is cold, this is of little consequence, but not unfrequently it is of a boiling temperature, and the mouth becomes filled with the heated liquid. The effects of this accident are not, as might be at first supposed, inflammation of the œsophagus or stomach, except in a few rare instances. When the fluid taken into the mouth is of a boiling temperature, it probably never enters these parts, being arrested in its course by a spasmodic action of the muscles of the pharynx, while at the same time an almost instantaneous attempt is made to expel it. During this effort at expulsion, it is probable that some of the fluid enters the upper orifice of the larynx, and this part of the air-passage, together with the interior of the mouth, and fauces, is scalded.

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* *Med.-Chir. Trans.* vol. xii.

Immediately upon the receipt of the injury, the little sufferer screams violently, instinctively applies both hands to the mouth, and thus notifies the part injured. On examining the mouth, the whole inner surface is found inflamed, swollen, and vesicated; the soft palate and fauces present a similar appearance; and this condition of the parts is attended with great pain, or even total inability to swallow. The child becomes restless, there is slight hoarseness of the voice, and symptoms of inflammatory fever soon appear. Within two or three hours the respiration becomes affected. Inspiration is performed with difficulty; this gradually increases, is accompanied by a hoarse croupy sound, and aggravated by occasional attacks of spasm. In many cases the child suffers from frequent vomiting. Unless these symptoms are soon relieved, the face becomes livid, the extremities cold, the respirations more hurried and oppressed, the voice is quite lost, and death takes place in a fit of suffocative spasm, or the child gradually sinks into a state of collapse. In some cases the little patients recover from imminent suffocation within three or four days, or even earlier, from the occurrence of the injury, under proper antiphlogistic treatment. In other cases death takes place from suffocation, and if this is prevented by the timely performance of laryngotomy, the child may be carried off at a later period by tracheal or pulmonary disease.

After death, inflammation of the lining membrane of the cheeks, fauces, and tongue, is observed; these parts being swollen, corrugated, and the mucous membrane raised into blisters. There is redness and swelling of the pharynx, and in one case related by Mr. Gillman,* "the œsophagus to within a short distance of the cardiac orifice of the stomach presented the usual appearance of a scald." The mucous membrane covering the epiglottis, the arytæno- and the glosso-epiglottic folds, are thickened, with effusion of lymph in the subjacent areolar tissue, occasionally to such an extent as to close the upper orifice of the larynx; but the œdema never extends below the true vocal cords. In some cases where the patient has survived only a few hours, the mucous membrane below the rima is quite healthy; in other cases, where the patient has lived a longer period, the mucous lining of the trachea and bronchi is highly inflamed, the bronchial tubes loaded with a thick viscid mucous fluid, and occasionally covered with an adventitious membrane, similar to what is produced in croup; in such cases the lungs are usually congested, and some part of the pulmonary tissue in a state of hepatisation.

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* *Med.-Chir. Trans.* vol. xii. p. 9.

The history and post-mortem appearances show that this form of injury produces violent inflammation of the larynx, which rapidly increases, and in which the patient soon dies suffocated; or death occurs at a later period from extension of the inflammation to the bronchi and lungs. Under such circumstances, the most active antiphlogistic treatment must be employed. Leeches should be applied to the throat in the immediate vicinity of the larynx, the number being proportioned to the age and strength of the patient, and the urgency of the symptoms. Mr. Porter remarks upon this remedy: "I scarcely recollect a case, even where bronchotomy afterwards became necessary, in which the application of leeches to the throat in the early stages was not followed by a marked, although it might be only a temporary, relief; and many cases have occurred in which a perseverance in such a line of practice has been attended with success as decided as it was unexpected."*

Counter-irritation in the form of a blister applied to the upper part of the front of the chest, or raising a blister in the same situation by applying the acetum lyttæ, appears to be of benefit in some cases when the symptoms are very urgent.

Calomel should also be administered. If the symptoms of inflammatory fever are intense, and the dyspnœa extreme, two or three grains may be given every hour until the symptoms are relieved, when the dose may be diminished and given at less frequent intervals, until all symptoms of inflammation have subsided. The advantage derived from the use of calomel in these cases was first pointed out by Dr. Wallace of Dublin; and numerous instances have occurred since his publication, in which the exhibition of this remedy has been attended with the most marked benefit. It occasionally happens that the fauces are so much swollen that the patient is unable to swallow; under such circumstances, calomel cannot be administered, and we must then trust to other remedies to subdue the inflammation. If the symptoms are not relieved, and suffocation appears imminent, laryngotomy must be performed without delay. It is almost impossible to lay down any precise rules as to when the operation becomes necessary; this must be left, to a certain extent, to the judgment and discretion of the practitioner, who must take each point in his patient's case into consideration; it should, however, always be remembered that the operation is performed to relieve the patient from impending suffocation, but that it has very little effect in subduing the inflammation set up by the injury.

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* Op. cit. p. 184.

Injury of the larynx from drinking the concentrated acids, or other irritant fluids. The concentrated acids, or other irritant fluids, are sometimes used by the suicide to destroy life, and at other times are taken accidentally. If taken intentionally, the fluid is swallowed without the slightest complaint of uneasiness or pain. Mr. Porter says,* "I have known a young girl, after taking sulphuric acid, sit quietly and drink tea with some females, who were afterwards suspected of poisoning her, although the dose had been so powerful that she died in a few hours; and I am aware of a man who took a second glass of the same acid, because he thought the first was not sufficiently quick in despatching him." In cases of this kind the larynx is seldom injured; notwithstanding the highly irritating nature of the liquid, and the pain that it must produce, the determination to swallow the fluid is so great, that it passes over the epiglottis, along the œsophagus, into the stomach, without producing any injury to the upper end of the air-passage. But if the fluid is taken accidentally, the same effect is produced as in those cases where boiling water is taken into the mouth. The presence of the irritating fluid produces such an amount of spasm of the muscles of the pharynx and larynx as entirely to arrest its course along the pharynx or œsophagus; at the same time, an instantaneous attempt is made to expel it, and the fluid is forcibly ejected through the nostrils and mouth, producing much injury to those parts. During this effort at expulsion, it is probable that some of the fluid enters the larynx, and this part of the air-passage becomes, in many instances, intensely inflamed. The post-mortem appearances consequently differ in these two classes of cases. In those instances in which the acid is taken intentionally, the lips and chin are charred and desiccated, the tongue is found black and charred, the soft palate and fauces highly vascular, the œsophagus greatly congested throughout its whole extent, and in parts of a very dark colour; the lining membrance of the stomach blackened, disintegrated, and lying flocculent and loose in the cavity of the organ; whereas, in those instances in which the fluid is taken accidentally, the injury is chiefly limited to the mouth, fauces, pharynx, and larynx.

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* Op. cit. p. 178.

In some of these cases it would appear that inflammation of the larynx, at least to such an extent as to impede respiration, never takes place. Mr. Porter says he has seen five instances of persons having swallowed sulphuric acid, two of whom recovered, and in none of them were there symptoms of obstructed respiration; other cases, however, occur, in which evidence of the existence of inflammation in the larynx is found after death, but not attended with any symptoms during life, or the symptoms are so slight that they rapidly yield under appropriate antiphlogistic treatment. In a case of poisoning by sulphuric acid, and in two cases of poisoning by corrosive sublimate, admitted into St. George's Hospital during the last few years, the upper part of the air-passage was in each case slightly inflamed. In the former case,—in which the patient, a man, æt. thirty-three, lived nine hours after taking a quantity of sulphuric acid,—besides the appearances usually noticed in these cases, the mucous membrane covering the epiglottis and upper part of the larynx was slightly thickened and of a pink colour. There was some vascularity of the upper part of the air-passages, and some congestion of the lungs. In this instance the patient died in a state of collapse, and there was no obstruction to respiration, nor any symptoms indicating inflammation of the larynx, noticed during life. In the two latter cases, one patient died five days, the other six days, after taking a quantity of the solution of bichloride of mercury; in both of these cases the epiglottis and the mucous membrane lining the larynx were inflamed, in one case with slight œdema and vascularity about the glottis, and in the other, recent lymph was found lining the mucous membrane of the epiglottis and interior of the larynx.

Cases, however, do occasionally happen, in which very acute symptoms of laryngitis come on after this accident. Under such circumstances, the same treatment should be adopted as is applicable to laryngitis from other causes. Leeches and fomentations should be used externally, and calomel administered in small but frequently-repeated doses. If the symptoms are not relieved by these means, and suffocation appears imminent, laryngotomy should be performed. In these cases, the Surgeon performs this operation to rescue the patient from impending death; but it is very seldom of more than temporary benefit, on account of the extensive mischief necessarily produced by the contact of the poison with the neighbouring parts, or more distant organs.

FOREIGN BODIES IN THE AIR-PASSAGES.

A person, previously in good health, is engaged in talking and laughing during a meal; suddenly he rises from the table, is seized with violent spasmodic cough, the eyes protrude from their sockets, blood or froth issues from the mouth and nose, he makes a few suffocative gasps for breath, turns black in the face, and either falls down insensible, or the symptoms subside for a time, only, however, to recur after a shorter or longer period. The great probability is, that these symptoms are occasioned by the introduction of a foreign substance into the air-passage. This accident is popularly supposed to occur during the act of swallowing, but it never can occur under these circumstances; during the process of deglutition, the larynx is elevated, the epiglottis falls over the upper aperture of the larynx, so as to completely close it, and so effectually as to prevent the entrance of the smallest morsel of food. But the accident frequently happens to a person engaged in talking and laughing while the mouth is filled with food, or contains some foreign substance. Preparatory to the act of speaking or laughing, a deep inspiration is necessary, by which the epiglottis is raised, the upper orifice of the larynx opened, and the margins of the glottis widely separated; the mind being probably engaged in interesting conversation, the vigilance of the muscles guarding the aperture of the larynx is lulled, and any object contained in the mouth is drawn by the current of inspired air into the larynx or trachea. It might at first be supposed that a foreign substance, after having passed through the rima into the trachea, could as easily be expelled through this opening; such a fortunate occurrence is, however, very rarely met with: during inspiration the margins of the glottis are widely separated, and placed in the most favourable position to allow the entrance of any foreign substance; but during expiration, and especially during the act of coughing, which the foreign body excites, the rima glottidis is much narrowed, and the spasm excited by the foreign substance impinging upon it still further prevents its exit. It may so happen that the foreign substance, if light and of small size, may be expelled in the fit of coughing which its presence produces. But if the body is of large size, and heavy, it usually falls into, and becomes permanently fixed in, some part of the air-passage, being retained for days, months, or years. It may be that the person has had, previous to these symptoms, some loose body in the mouth, which he fancies he has swallowed; or was engaged in playing with a piece of money, for the amusement of others, by throwing it up into the air and attempting to catch it in his mouth. In whichever way the accident may have happened, the above-described symptoms coming on suddenly, the person being previously in perfect health, indicate the probable existence of a foreign body in some part of the air-passage. But the introduction of a foreign body is sometimes effected in a manner very different to this, and it becomes a matter of some moment, in the diagnosis of the case, to be acquainted with some of the many curious ways in which such a substance may be introduced. Thus, foreign bodies occasionally find their way from the pharynx and œsophagus into the air-passage. A stout, hearty labourer died suddenly whilst eating his Sunday's dinner of boiled beef and cabbage. The body was examined on the following day. A piece of meat was found in the rima glottidis, and a quantity of masticated beef and cabbage was found in the trachea, the bronchi, and even in the most minute ramifications of the bronchial tubes. It seems probable that this man had filled his stomach so much as to produce vomiting, and that, endeavouring to inspire at the time that the food was being rejected, it had entered the air-passage.*

An ulcerated opening is occasionally effected between the trachea and œsophagus, the result of long-continued disease of the latter tube, of which I have seen two instances. In cases similar to these, foreign bodies have passed from the œsophagus into the trachea. Foreign bodies may enter through an artificial opening, as in wounds of the throat, and suffocation sometimes takes place from the introduction of blood into the trachea during operations about the mouth and throat, and even during the performance of tracheotomy,—a consequence very likely to ensue if the patient is rendered insensible by the administration of chloroform. Cases are mentioned of lumbrici having made their way from the stomach into the pharynx, and, entering the larynx, produced death by suffocation, numerous instances of which are narrated both by ancient and modern authors. Perhaps one of the most remarkable instances of the source from which a foreign body may be derived is recorded by Mr. Edwards of Wolverhampton, in the thirty-seventh volume of the *Medico-Chirurgical Transactions.* A boy, about eight years of age, was playing with some other boys of his own age, when it was said that he was offended, or struck by one of his playfellows: he ran off to tell his mother; and just as he got home, a distance of thirty yards, the child seemed in a fit: he denied having swallowed any thing, struggled violently, the head being thrown forcibly back; the countenance was anxious, the face discoloured, and he said once or twice that he should die. Tracheotomy was performed about half an hour from the commencement of the symptoms, and artificial respiration attempted, but without any beneficial effect. Fixed in the rima glottidis was a body about an inch in length; on further examination, it was evident that this body was a bronchial gland, which had become detached, and had made its way by ulceration through the bronchus into the air-passage, for, on slitting open the trachea, the ulcerated opening was found through which the gland had passed. Another remarkable instance of a foreign body getting into the windpipe without passing through the rima glottidis is mentioned by De la Martinière.* A child, nine or ten years of age, amusing himself with cracking a small whip, was suddenly seized with extreme difficulty of breathing, and soon exhibited all the symptoms of approaching suffocation. He complained by gesture of some impediment in the trachea. The Surgeons who saw him, aware that he had never been left alone, and that he could not have put any thing into his mouth, did not suspect the existence of a foreign body impeding respiration. He was bled, the throat examined, and an œsophageal bougie passed, without making any discovery. The symptoms became more urgent, and De la Martinière saw him an hour after. On examining the neck externally, a small red spot was found on its fore part, immediately below the cricoid cartilage, and beneath it was felt, deeply, a little circumscribed ganglion, as large as a lentil. It was at once determined to cut through the skin and fat upon this spot. On laying bare the trachea, an irregularity was felt projecting at least a line above its convexity, and, after vain endeavours to seize it with the dressing forceps, the body was finally laid hold of with a pair of hair-nippers, and on drawing it out was found to be a large copper pin, without a head, about an inch and a quarter long, which had been fixed in the lash of the whip, and had pierced through the windpipe from left to right. The child got well in a few days.

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* Ryland, p. 280.

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* "Observations sur un corps étranger," &c., in *Mém. de l'Acad. de Chir.* vol. v. p. 521.

To diagnose with certainty the existence of a foreign substance in the air-passages, requires the utmost care and vigilance on the part of the Surgeon, as the symptoms which attend this accident are liable to be mistaken for those of other affections. A most careful examination should be made of the chest; any derangement of the digestive or respiratory systems should not be overlooked, as any of these causes—irritation of the nerves which supply the larynx, from the pressure of a tumour, or enlargement of the cervical glands—may induce a train of symptoms closely resembling those occasioned by the presence of a foreign body. In children more especially, among whom this accident frequently occurs, the diagnosis is always obscure, as they seldom understand the nature of their complaint, and are unable to give any accurate account of it. It should be remembered also that a foreign substance may be impacted in the upper part of the pharynx or in the œsophagus, and, by its pressure on the larynx, excite a spasmodic action of the laryngeal muscles, and produce death by suffocation. Stokes* mentions an instance in which a piece of money lodging in the œsophagus produced croupy breathing and laryngeal symptoms, and another case in which such severe symptoms were produced by a plum-stone in the œsophagus, that his first impulse was to perform tracheotomy with his penknife; an œsophageal bougie was, however, introduced, and, the substance having been pushed into the stomach, the symptoms ceased, and a day or two after the plum-stone was voided by stool. Habicot† also had recourse to this operation on a lad, fourteen years of age, who attempted to swallow nine pistoles wrapped up in a piece of cloth. The packet, which was very large, could not pass the narrow part of the pharynx, and the boy was on the point of being suffocated by the pressure which the foreign body made on the trachea, when bronchotomy was performed. The operation was successful, and the pieces of gold were subsequently pushed into the stomach with a leaden probe, and were discharged from the anus eight or ten days afterwards.

The introduction of a foreign substance into the air-passage often occurs to persons who are drunk, and at the same time engaged in eating a meal; and the symptoms produced are liable to be mistaken for an apoplectic seizure. Mr. Porter has examined seven cases in which death had been produced from suffocation in this way;* and a similar case is recorded by Dr. L. Beale in the *Transactions of the Pathological Society.*† Cases occasionally come under the notice of the Surgeon, in which the presence of a foreign substance in the air-passage is suspected, whilst the attendant symptoms may depend upon laryngitis, croup, or spasm of the glottis, connected with ulceration of the larynx or trachea, or upon aneurism of the aorta pressing on the trachea or bronchial tubes, or upon pressure of a tumour on the laryngeal nerves; and other cases occur in which a foreign substance exists in the trachea, and the symptoms are believed to be dependent upon an attack of croup, or other inflammatory affection of the air-passages.

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* Stokes, Wm., M.D., *A Treatise on the Diagnosis and Treatment of Diseases of the Chest*, Dublin, 1827, 8vo.

† *Mém. de l'Acad. de Chirurgie*, tom. xii. p. 243, ed. in 12mo.

As an instance of the former class of cases, I may mention that of a boy, æt. three, who was admitted into St. George's Hospital in the year 1851. On the 5th of March, while playing with a small button, he put it in his mouth, and it was supposed to have slipped down his throat; he had been previously in good health, and continued so for three days after the occurrence. On the 8th, there was difficulty of breathing, at intervals, with convulsions, foaming at the mouth, lividity of the countenance, a croupy sound during inspiration, and partial loss of voice. Emetics had been used without relief, and calomel, with Dover's powder, was ordered, which produced vomiting; but no button was expelled. On the 21st of March, the symptoms remaining the same, the larynx was examined by the finger, but no foreign body was felt; laryngotomy was afterwards performed, and several explorations made in the glottis with various instruments, but no extraneous substance could be found. The dyspnœa and croupy sound continued at intervals; and on the following morning a sudden fit of spasm occurred, which ended fatally. No foreign substance was found in the air-passage after death. There was a little lymph upon the mucous membrane of the glottis; the mucous membrane lining the trachea and bronchi was very vascular, and the bronchial tubes contained much muco-purulent fluid.

But a foreign substance may be present in the air-passage, and the attendant symptoms be mistaken for those of croup. I once saw a little boy suffering from such urgent dyspnœa that it was necessary to open the trachea. The symptoms came on, according to his mother's account, on the disappearance of a cherry-stone, with which he was playing; but they simulated those of croup so closely that no further attempt was made to search for a foreign body. The boy died; and, after death, I found the cherry-stone in the trachea.*

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* *Dublin Medical Press*, Feb. 9, 1859.

† *Path. Trans.* 1851-52, p. 250.

A foreign substance sometimes enters the air-passage at the same time that an injury is received in the neck or chest, and the difficulty of breathing which follows may be supposed to result from the injury, the existence of the foreign substance being overlooked. A child, playing in the street, was struck with the shaft of a gig or jaunting-car, and the bystanders declared that the wheel had passed over her breast. When taken up, she recovered in a few minutes, so far as to be able to walk home without assistance; but from the instant the accident occurred, the breathing became croupy. She had an intermittent cough, suffered from incessant restlessness, and continued in this state about thirty-eight hours, when she was seized with a paroxysm of convulsive cough, flung her head in agony upon the pillow, and was dead in an instant. Not a trace of injury to the thorax could be detected. In the larynx was found part of an almond-shell, its rough and broken edge entangled in the rima glottidis. From this examination, it was evident that the child had the fragment of shell in her mouth at the time she was struck, and had unconsciously swallowed it, and it passed into the trachea. Mr. Porter says, "In this case, the existence of a foreign body in the larynx or trachea had never been suspected, nor was I aware that any symptom observed could have warranted such a supposition. It was considered as difficult breathing, resulting from injury of the neck or chest."†

The cases that have been brought forward serve to show the extreme care that is required in forming an accurate diagnosis of this accident. The history of the patient should first be inquired into, in order to ascertain if any previous pectoral or laryngeal disease existed. The Surgeon should inquire whether any foreign substance was in the mouth at the time of the accident, and, if so, its size and shape. From a portion of food or other foreign body lodged in the pharynx or œsophagus, the accident may be known, by examining the pharynx with the finger, by the facility with which deglutition is accomplished, and by passing a probang down the œsophagus; an operation that should always be performed where there is any doubt in the mind of the Surgeon as to the nature of the case. From croup or laryngitis it may be distinguished by the sudden way in which the symptoms make their appearance, by the absence of pyrexia, by the difficulty of breathing being intermittent, the paroxysms coming on at intervals of an hour or two, the dyspnœa being especially great during expiration,—the reverse of what is observed in laryngitis.

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* A somewhat analogous case is recorded by Dr. Conway Evans in the *Ed. Med. Journal*, 1860, p. 636.

† Op. cit., p. 193.

The foreign substances that have been found in the air-passages are of very various kind: portions of food, plum- and cherry-stones, of which there are a great many instances, peas, acorns, the claw of a crab, which was suddenly drawn into the windpipe whilst a child was sucking it, teeth, portions of bone, pebbles, a small arrow, pieces of money, nut-shells, buttons, a button-mould, a shot, a musket-ball, a shell, nails, beans of every description, melon and pumpkin seeds, ears of grass or corn, worms, leeches, a detached bronchial gland, besides a great many other substances, animal, vegetable, and mineral.

In the generality of cases, only one foreign body enters this tube, but cases have occurred in which "two, three, or even four foreign substances have entered the air-tube, either simultaneously or successively."* This probably depends upon several foreign bodies being contained in the mouth at the time of the accident.

Foreign substances of a vegetable or animal nature, such as peas, beans, portions of meat, &c. are liable to become enlarged by the imbibition of moisture when retained beyond a certain period in the air-passages, and consequently occlude more closely the part of the tube in which they may be lodged; and all foreign substances are liable to become encrusted with inspissated mucus or lymph after remaining long in the air-passage. These facts are of considerable practical interest, as they show how, the longer a foreign substance is retained, the greater danger there is of increased obstruction to respiration.

We must now consider the different situations which a foreign substance may occupy.

It may become impacted in the superior aperture of the larynx, or in its cavity, or in one of the ventricles of the larynx, or become wedged in the chink of the glottis.

Sometimes it becomes arrested in the cavity of the larynx below the glottis.

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* Gross, *Practical Treatise on Foreign Bodies in the Air-passages*, 1854.

It may pass into the trachea, and occasionally, but very rarely, becomes arrested there, generally descending into one of the bronchi, usually the right one. The foreign substance, instead of being fixed in some part of the trachea, may move up and down this canal during respiration, passing from one bronchial tube into the other, or from these canals into the trachea, or from the trachea into the larynx.

Finally, it may pass into one of the second or third divisions of the bronchi.

In twenty-one cases analysed by Dr. Gross, in which death took place without operation, and without expulsion of the foreign body: "in four, the foreign substance was situated in the larynx; in one, partly in the trachea, partly in the larynx; in three, in the trachea; in eleven, in the right bronchial tube; in one, in the lung; in one, in the right pleural cavity."

"In forty-two cases subjected to operation or general treatment, the extraneous substance was situated twice positively, and eleven times probably, in the right bronchial tube; four times certainly, and four times probably, in the left bronchial tube; seven times in the trachea, and fourteen times in the larynx." It would thus appear that the larynx and the right bronchial tube are the most frequent situations in which foreign substances are arrested.

The situation of the foreign body is frequently influenced by its size, weight, and shape. A small, smooth, heavy body, such as a shot, pea, bean, or pebble, is more likely to descend into one of the bronchial tubes than one less heavy, and more rugged and uneven.

When a foreign body has passed into the air-passage, the results that may happen vary much in different cases. The foreign substance may be expelled through the glottis immediately after its entrance during a violent fit of coughing, or it may be got rid of after a variable period of time, either before or after producing serious structural lesions in the air-passages. Death may occur almost instantly after its admission, from suffocation; and this is especially the case where the foreign substance becomes impacted in the superior aperture of the larynx or in its cavity, or is wedged in the chink of the glottis; or suffocation may be induced more slowly from the accumulation of mucus around the impacted substance. Fatal hæmorrhage may occur, as in Rokitansky's case,* in which a small dart had been sucked into the trachea, and was forced into the innominate artery during a fit of coughing. A foreign substance may produce only slight mischief; as, for instance, when it lies in one of the ventricles of the larynx; more frequently it produces great structural changes, congestion and inflammation of the mucous membrane in contact with which it is lying, occasionally followed by inflammation of the larynx, or of the trachea and bronchi, especially if the foreign substance is large, produces great inconvenience, or is retained for a long time; and the danger of severe inflammation appears to be much greater when the foreign body is lodged in the bronchial tubes than when arrested in the larynx or trachea. When a foreign substance is retained in the bronchial tubes, serious structural changes occur in the lungs; congestion, followed by pneumonia, may involve one lobe only, or the whole lung, or it may attack both lungs simultaneously, the affected organ becoming hepatised, and, if the diseased action continues, infiltrated with pus, abscess forming, which may discharge for weeks, months, or years. In more chronic cases, coagulable lymph may be thrown out, and much accumulation of mucus may take place around the extraneous substance, the mucous membrane in contact with it becoming thickened, congested, and in some cases ulcerated, and the foreign substance may make its way from the trachea or bronchus into the tissue of the lung; it may even travel from the substance of the lung into the cavity of the pleura, producing empyema, and it is sometimes discharged through an abscess, ulcer, or fistula in the walls of the chest. Various substances, as bullets, wadding, and splinters, may thus be got rid of, after having been retained for an indefinite period in the bronchial tubes or lung.

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* *Pathological Anatomy*, vol. iv. p. 37 (translated by Day).

In some cases, the foreign substance, when retained, appears to serve as a nucleus for the deposition of tubercle, which accumulates in large masses around it, death taking place from symptoms resembling those of phthisis. More rarely, the foreign body becomes encysted, and so may remain for a long time perfectly harmless. Such a termination is, however, very rare. Œdema of the larynx, pulmonary emphysema, and emphysema of the cellular tissue of the neck; pleurisy, with effusion of lymph and serum in the pleural cavity, are also occasionally found after the retention of a foreign substance, and more especially if it is situated near the surface of the lung, or when it has passed by ulceration into the pleural cavity.

The general symptoms present in cases where a foreign substance exists in the air-passages are, pain in the larynx, trachea, or chest; cough, alteration of the voice, expectoration, altered respiration, as evinced by auscultation and percussion; emphysema, inability to lie in certain positions, and impairment of the general health. These symptoms vary according to circumstances, and cases occasionally occur in which none of them make their appearance for a very considerable period. Louis gives an instance in which, after the first few minutes, the patient did not experience a bad symptom for a year, at the end of which time he coughed up a cherry-stone, followed by such a copious expectoration, that he died exhausted in three days.

When a foreign substance is impacted in the superior aperture of the larynx, or wedged in the rima glottidis, the symptoms present depend upon the extent to which respiration is impeded, and the amount of mechanical injury which the foreign substance produces; consequently, the symptoms vary according to the size and nature of the extraneous body. When the foreign body is large, such as a fragment of food, and firmly impacted, almost instant death takes place from suffocation. It occasionally happens that a foreign body, after being lodged in the trachea for a variable period, is propelled, in a paroxysm of coughing, into the chink of the glottis, where it becomes impacted, when instant death occurs. In the case of a child (already related, p. 299) who died from suffocation, after suffering for thirty-eight hours from dyspnœa and convulsive cough, Mr. Porter found a portion of an almond-shell entangled in the rima glottidis. In this case the foreign substance had been lodged in the trachea, until a paroxysm of cough had thrown it into the rima, which it had completely blocked up.

When the cavity of the larynx contains a foreign substance, the size of which is insufficient to totally exclude the passage of air, instant death does not always take place, and the symptoms which are then produced will depend much upon the nature of the extraneous substance. If it is sharp, or angular, the symptoms are usually very severe. Pain is complained of in the region of the larynx; there is a constant feeling of suffocation, which occasions the patient the greatest distress; violent and incessant attacks of cough, with croupy respiration, hoarseness, more or less change or total loss of voice, are the symptoms generally present. In cases of this kind there is seldom any intermission of the symptoms, and this circumstance, together with the history of the case, the fixed pain in the larynx, and the absence of morbid sounds on auscultating the chest, would show the larynx to be the seat of the extraneous substance. Unless these symptoms are relieved by the expulsion of the foreign body during a convulsive fit of coughing, or by an operation, death occurs in a short period. If, however, as Mr. Porter observes, "the body be round and polished and small, it shall create no symptoms of distress, except the cough and the difficulty of breathing; and the patient may exist for a long time without the occurrence of those morbid actions which render the accident certainly fatal."

Foreign substances occasionally become lodged in one of the ventricles of the larynx. The effects they produce when retained in this situation are similar to those noticed in the preceding cases; but they are less severe, and danger to life is less imminent. A young man was admitted into the Hôtel Dieu, having suffered for six weeks from a severe cough, accompanied by frequent attacks of suffocation, and great uneasiness experienced in the region of the larynx. Upon inquiry, these symptoms were ascertained to have arisen from a button-mould having passed into the larynx. The trachea was opened, but though the button was felt, it could not be extracted with the finger. The cricoid cartilage was then divided, and the foreign body extracted from the left ventricle of the larynx.* But patients may live a very long period when a foreign body occupies this situation. Desault† reports a case, in which a cherry-stone was lodged in one of the ventricles of the larynx; the patient would not consent to an operation, and died in two years of laryngeal disease: and Dr. Watson‡ states that there is one instance on record, in which a piece of gold was lodged for years in one of the ventricles of the larynx, without distressing consequences.

The foreign body occasionally passes through the chink of the glottis, and becomes fixed in the lower part of the larynx or in the trachea immediately below the cricoid cartilage.§ In this situation the extraneous substance produces, comparatively, little distress, after the first symptoms indicating its introduction have passed off. Pain and tenderness are complained of corresponding to the point where the foreign body is lodged; the voice is unaffected, a wheezing, whistling, or croupy sound is heard in inspiration and expiration; the patient, a child, has been known to laugh, speak, and eat, as if nothing had happened; and occasionally there is entire absence of cough.

The foreign substance may pass beyond the larynx into the trachea. In cases of this kind, the patient, who has probably had some foreign substance in the mouth, which is supposed to have been swallowed, is seized with a convulsive cough, threatening suffocation, and this having subsided, the symptoms that are then produced vary according to the size, weight, and figure of the extraneous substance, and also whether it is fixed or movable.* If the body is light, of small size, with no great irregularity of surface, such as a cherry- or plum-stone, it may shift its situation constantly, and thus produce a train of symptoms very indicative of the nature of the injury. Paroxysms of cough occur, especially violent when the foreign body is driven up against the glottis, and occasionally succeeded by a long and sonorous inspiration like hooping-cough. The cough is usually harsh, dry, and hard; and during these paroxysms the face is purple, the cheeks swollen, the eyes protruding, and a quantity of saliva flows from the patient's mouth. The cough is succeeded by intervals of comparative quiet, during which the patient suffers little inconvenience; and this absence of permanency in the symptoms is very liable to mislead the patient's friends, and even his medical attendant. Sometimes the foreign substance may be felt by the patient to strike the walls of the trachea during its movements upwards and downwards within this tube, especially during a forced expiration, when the foreign body is driven up to the larynx.

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* Pelletan, *Clinique Chirurgicale*, tome i. p. 8.

† *Œuvres Chir.* t. ii. p. 258.

‡ *Lectures on the Practice of Physic*, 4th ed., vol. ii. p. 436.

§ See cases recorded by Mr. Cæsar Hawkins in *Med.-Chir. Trans.* vol. xxiii. p. 99; and one by Mr. Bullock, *Med. Gazette*, vol. xviii.

The situation of the foreign body is occasionally indicated by some uneasiness or pain referred to the lower part of the larynx, the front of the neck, or just behind the sterno-clavicular articulation, and this is more severe when the foreign body is rough and jagged. In addition to these symptoms, M. Louis noticed in one case well-marked emphysema on both sides of the neck, just above the clavicle. If the foreign substance is heavy, it will not be driven upwards towards the larynx in the act of coughing; consequently the inconvenience it produces, and the immediate danger, is less than where the foreign substance is light and freely movable; but the ultimate danger to the patient is quite as great if the extraneous substance is allowed to remain; inflammation of the lungs, and death, ultimately supervening.

If the foreign body is of large size and very irregular, it may be impacted in the trachea, producing more or less obstruction to respiration on both sides of the chest; and this may become aggravated by the abundant secretion of mucus and coagulable lymph which is thrown out from the lining membrane.

If of small size, and heavy, it will descend to the lower part of one of the bronchi (usually the right), or into one of its subdivisions, obstructing respiration to a less extent.

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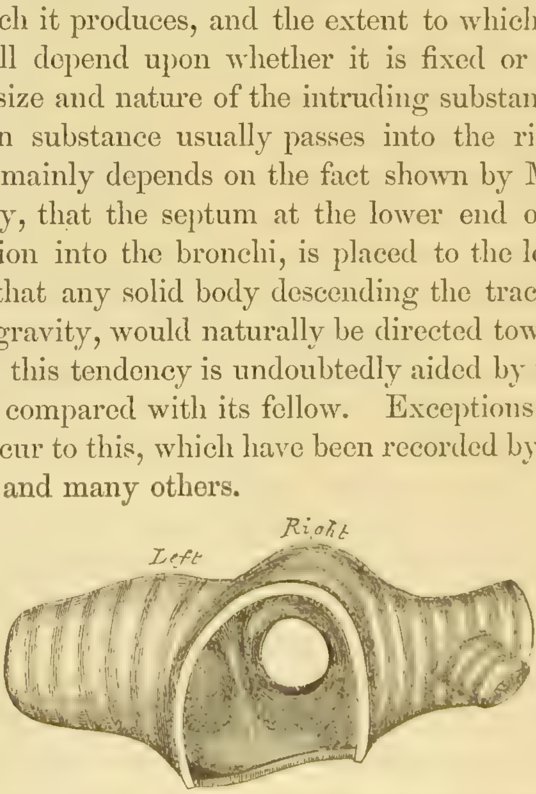
* See a paper by Sir B. C. Brodie, Bart., *Med.-Chir. Trans.* vol. xxvi. p. 286.

If the foreign body is allowed to remain, the progress of the symptoms presents much variety in different cases. Death may occur from spasm of the glottis, or, the foreign body being propelled upwards into the rima, death may take place by its mechanically preventing the passage of air, or rupture of one of the cerebral blood-vessels may be produced during one of the fits of coughing. At a later period the lungs may become congested and emphysematous, or bronchitis, pneumonia, or pleurisy, may supervene, these symptoms occurring in some instances very rapidly, in other cases at a more remote period.

When a foreign substance enters one of the bronchi, the symptoms which it produces, and the extent to which respiration is obstructed, will depend upon whether it is fixed or movable, and also upon the size and nature of the intruding substance.

The foreign substance usually passes into the right bronchus. This probably mainly depends on the fact shown by Mr. Goodall of Dublin, namely, that the septum at the lower end of the trachea, at its subdivision into the bronchi, is placed to the left of the median line; so that any solid body descending the trachea, by virtue of the laws of gravity, would naturally be directed towards the right bronchus; and this tendency is undoubtedly aided by the larger size of this tube as compared with its fellow. Exceptions, however, do occasionally occur to this, which have been recorded by Rokitansky,[*] Dr. Hughes,[†] and many others.



Transverse section of the Trachea just above its bifurcation, with a bird's-eye view of the interior. (From *Gray's Anatomy*.)

As might naturally be expected, the impaction of a foreign substance in one of the bronchi will prevent the passage of air into the lung of that side. In some cases there is entire absence of the respiratory murmur on one side; which would lead to the conclusion that the bronchus is completely obstructed. In other cases the obstruction is more partial; from the intruding substance being lodged in one of the primary divisions of the bronchus, the vesicular murmur is then absent in some part of the lung, percussion in each case affording its usual clear sound. On examining the chest, it will be found, during inspiration, to rise less on the affected side than on the sound side, and the respiration in the opposite lung will generally be puerile. Fixed pain is occasionally referred to the upper part of the chest, when the substance is immovable, and the constancy of pain on one or the other side may, with other symptoms, serve to indicate the position of the foreign body. The voice may be hoarse, and the respiratory movements accompanied with a wheezing noise; cough may also be present, aggravated probably by a deep inspiration, and accompanied by mucous or purulent expectoration. Inflammation of the lung, sooner or later, is added to these symptoms, which is revealed by its usual auscultatory signs; and if the foreign body is not expelled by nature, or removed by the Surgeon, the expectoration becomes more copious, and is ultimately highly offensive, and of a dark colour; the cough is more troublesome, and aggravated by any exertion or change of position; the patient suffers from disturbed nights, daily paroxysms of fever, and night-sweats; general depression ensues, and the unfortunate sufferer dies exhausted.

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[*] *Pathol. Anat.* vol. iv. p. 37. [†] *Dublin Quart. Jour.* 1855.

In all cases where a foreign body has passed into the air-passages, measures should be adopted as soon as possible to remove it; so long as it remains there, the patient's life is in imminent danger. Experience has shown that, although foreign substances have occasionally been expelled by the spontaneous efforts of the patient, and under the influence of certain remedies, as emetics, the practitioner is not justified, under any circumstances, in recommending such remedies; too frequently they only increase the sufferings of the patient, by impelling the foreign substance against the larynx, whereby life is endangered.

Inversion of the body, together with succussion, has been attended in some few cases with a happy result. Dr. James Duncan has recorded, in the *Northern Journal of Medicine*, the case of a man who was amusing himself with tossing up a shilling and catching it in his mouth. Suddenly it fell into his larynx, and produced violent cough and severe dyspnœa, which gradually subsided. The difficulty of breathing returned in paroxysms upon his making a deep inspiration, or after certain movements of the body. When the larynx was compressed externally, the man felt that the coin was lying opposite the cricoid cartilage. He was now held with his head downwards by three strong men, was shaken once or twice in that position, and his larynx was moved from side to side, when the shilling reëntered his mouth and dropped out upon the floor. During this process he suffered neither cough nor dyspnœa. My friend Dr. G. B. Halford, when house-surgeon at the Westminster Hospital, adopted successfully a similar mode of treatment in the case of a man who, on the evening previous to his admission, had accidentally let slip a shilling into his windpipe.

Notwithstanding the success of the treatment adopted in these and a few similar cases, it not unfrequently produces great distress, and, occasionally, endangers the life of the patient, unless the attempt at removal is preceded by making an artificial opening in the windpipe. By adopting this measure, a free aperture exists for respiration, spasm of the glottis disappears, and the foreign substance is either expelled through the artificial opening, or falls through the glottis into the mouth.

When the symptoms indicate with certainty the existence of a foreign body in the larynx, laryngotomy should be performed; unless the patient is very young, when the trachea should be opened instead. Before proceeding to either operation, chloroform should be administered, which, by quieting the patient, and allaying irritability of the respiratory organs, favours the expulsion of the foreign substance. In performing laryngotomy for the extraction of a foreign body from the larynx, the opening in the crico-thyroid space should be as large as possible. As soon as the larynx is opened, the foreign body may escape from the wound during expiration or in a fit of coughing, or may be driven up through the glottis into the mouth, and either at once be ejected, or swallowed by the patient. If, however, the foreign substance cannot be got rid of by these means, the patient's body should be inverted, and the larynx compressed externally, or succussion may be tried. If these means fail, the larynx should be carefully explored with a probe, and the situation of the substance ascertained; when it should be gently extracted by a pair of forceps through the wound. This should be enlarged, if necessary, by carrying the incision upwards through the thyroid cartilage, or downwards through the cricoid, when the foreign substance may be pushed up by a bougie, or the finger, through the glottis, into the mouth.

When the foreign body is lodged in the trachea or bronchus, tracheotomy should be performed; and it is of especial importance to make the opening into this tube of large size. The opening should be at least an inch and a quarter in length in the adult, and not less than one inch in the child. I have, in more than one instance, seen much difficulty experienced in the attempt to remove a foreign body when the opening in the trachea was small, the substance having been discharged easily on enlargement of the wound. As soon as the windpipe is opened, the foreign substance, if loose in the tube, may be expelled through the wound, sometimes with considerable force, and to some distance ;—in one case in which I saw this happen, the Surgeon was on the point of laying open the larynx, with the intention of making a more complete exploration, when the nurse discovered the foreign substance, a small pebble, encased in mucus, lying on the bed-clothes; it had, no doubt, been expelled on the enlargement of the tracheal wound, without the Surgeon being aware of its having been ejected. Or the foreign substance may become lodged on the margins or in the neighbourhood of the wound, when it should be removed with forceps; or it may pass along the natural route, through the gullet into the mouth. If this result should not occur, which is not unlikely if the substance has descended into the bronchus, the body of the patient should be inverted, and shaken three or four times, or the upper part of the back should be struck smartly two or three times with the hand; by which it is to be hoped that the foreign substance may be dislodged. If this mode of treatment is found insufficient to dislodge the foreign substance from the bronchus, an attempt should be made to extract it by means of forceps. Although several cases are recorded in which the extraction of a foreign substance from the bronchus has been successfully performed by the introduction of the forceps, there can be little doubt that it is a difficult and dangerous proceeding, and should never be resorted to until other milder measures have failed. The introduction of any instrument into the trachea or bronchus usually excites violent convulsive cough, with heaving of the chest, and lividity of the face. Sir B. Brodie remarks upon this point, "In the dead body, with the assistance of proper forceps, there is no great difficulty in extracting a sixpence or a half-sovereign from the bronchus. But even here it is not always accomplished on the first trial. If the forceps be, as they ought to be, carefully and gently handled, the blades may actually slide over the surface of the coin without any sensation being communicated to the hand of the Surgeon which will make him aware of the circumstance; or they may be passed downwards on one side of the bronchus, while the coin lies on the other. In the attempt to seize it, the forceps sometimes grasps the bifurcation of the trachea, or one of the subdivisions of the bronchus, instead of the foreign body. Including the depth of the external wound, the instrument must be introduced to the distance of from four and a half to five inches before it reaches to the upper extremity of the bronchus; and in order that the whole of the bronchus should be explored, it must penetrate still one inch and a half further. But in the living person there are difficulties of which no knowledge can be obtained from experiments on the dead body. We found that every attempt to use the forceps occasioned a convulsive action of the diaphragm and abdominal muscles, and violent coughing." If, however, all other means fail to remove the foreign substance, careful exploration should be made in the bronchus with the forceps or blunt hook, and an attempt made to extract it. It is hardly necessary to say that these explorations should be conducted in the most gentle manner, and should never be continued longer than a few seconds at a time.

If the foreign substance resists all means of removal, the patient should be placed in bed, the edges of the wound in the trachea kept open, and the front of the neck covered with a piece of gauze, to prevent the ingress of any additional substance.

Laryngotomy and Tracheotomy.

The air-passage may be opened in three different situations: through the crico-thyroid membrane (laryngotomy), through the cricoid cartilage and upper rings of the trachea (laryngo-tracheotomy), or through the trachea below the isthmus of the thyroid gland (tracheotomy).

Laryngotomy. The crico-thyroid space, in which this operation is performed, is very superficial, and may be easily felt beneath the skin as a depressed spot, about an inch below the pomum Adami; it is crossed transversely by a small artery, the crico-thyroid, the division of which is seldom accompanied by much hæmorrhage. Laryngotomy is, anatomically considered, a very simple operation, can most readily be performed, and should always be preferred when particular circumstances do not render the operation of tracheotomy absolutely necessary. The operation is performed thus: The head being thrown back, and steadied by an assistant, the finger is passed over the front of the neck, and the crico-thyroid depression felt for. The larynx having been fixed, a vertical incision, about an inch in length, is made through the skin, in the middle line, over this spot; and when all bleeding has ceased, the crico-thyroid membrane is divided to a sufficient extent to allow of the introduction of a large curved tube. If the opening in the membrane is not sufficiently large, it may be lengthened by continuing the incision through the cricoid cartilage. In some cases the introduction of the tube is borne very quietly; in others, it produces much irritation, cough, and sense of choking. If such be the case, the tube must be removed, and the Surgeon may then adopt the plan, suggested by Mr. Lawrence, of cutting out a small piece of the cricoid cartilage and the neighbouring membrane. Laryngotomy is more suitable in adult males than in females or children, because the larynx is larger, and the crico-thyroid space very wide.

This apparently simple operation requires caution in its performance. I have known an instance in which a Surgeon, called on suddenly to perform it, cut down through the thyro-hyoid space, instead of through the crico-thyroid; and in another case, the incision through the integument was made in the usual situation, and the crico-thyroid membrane divided, but the tube was passed down between this membrane and the mucous lining of the air-tube, the cavity of the larynx not having been opened into at all.

Tracheotomy. In this operation the trachea is usually opened below the isthmus of the thyroid gland. The shoulders should be well raised, and the head moderately extended, which throws the windpipe forwards, and stretches the skin of the neck; the head should be supported by an assistant, and, if the patient is a child, it is a good plan to confine the limbs by means of a towel pinned round the body; an incision, about two inches in length, is made through the skin in the median line of the neck, from a little below the cricoid cartilage to the top of the sternum. The anterior jugular veins should be avoided by keeping exactly in the median line; the deep fascia should then be cut through, and the contiguous borders of the sterno-hyoid muscles separated from each other. A quantity of loose areolar tissue, containing the inferior thyroid veins, must then be separated from the front of the trachea with the handle of the scalpel; and when the trachea is well exposed, it should be opened by inserting the knife into it, dividing two or three of its rings from below upwards. Opening the trachea may be facilitated by directing the patient, if he is conscious, to swallow; by which the larynx is raised, and the windpipe elongated and made tense.

One of the chief dangers to be guarded against in this operation is the occurrence of hæmorrhage. This may arise from division of the isthmus of the thyroid gland, or from a wound of either of its lobes; from wound of the inferior thyroid veins which lie in front of the trachea; from wound of the carotid, or from the division of some unusual arterial branch. The anterior jugular veins may be avoided by making the incisions exactly in the median line. If the isthmus of the thyroid gland is likely to be interfered with, it should be pushed upwards; for although complete division of it is not always followed by hæmorrhage, it is very frequently so,—this difference probably depending on the variation in the thickness of the isthmus in different subjects. If much hæmorrhage follows the accidental division of the branches of the inferior thyroid veins, the bleeding should be restrained by pressure, or, if necessary, by ligature. Desault mentions that the carotid was opened in an operation for tracheotomy, in consequence of the trachea not being firmly fixed, and the patient was lost. Caution on the part of the operator is all that is necessary to avoid this vessel, or any unusual arterial branch ascending in front of the trachea.* Under all circumstances, it is of the greatest importance to use the knife as little as possible during the latter part of the operation, and to restrain all hæmorrhage before the trachea is opened, as blood may otherwise pass into the trachea and suffocate the patient; an occurrence which has not unfrequently happened. In children especially the dissection requires great caution, on account of their extreme restlessness; and it is a good plan to transfix and steady the trachea with a sharp hook, before opening it. It frequently happens that the danger of suffocation is so imminent before and during the operation, that it becomes of essential importance to open the trachea, and introduce the canula as rapidly as possible. It is in these cases more especially that danger is to be apprehended from blood running into the windpipe, the rapidity with which it is necessary to perform the operation adding to the risk of hæmorrhage occurring. If the amount of blood which passes into the trachea is small, a violent fit of spasmodic cough will, in all probability, expel it through the canula. If the hæmorrhage is more considerable, and the patient a child, he may be turned upon his face, to favour the escape of the blood, and to prevent the entrance of more. But sometimes the amount of blood which gains admission into the tube is so great, and the patient is so debilitated, that he has not strength to expectorate; under these circumstances, the Surgeon's lips should

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* In Macilwain's *Surgical Observations*, p. 335, a case is recorded in which the arteria innominata crossed the trachea in the situation in which this tube is opened in tracheotomy, so that it was thought advisable not to proceed with the operation.

be applied to the wound, or to a catheter introduced into the trachea, the blood removed by suction, and artificial respiration performed. The hæmorrhage may be considerably restrained by introducing the canula as soon as possible, so as to allow free ingress of air; for the obstructed respiration, together with the struggles of the patient, produce great engorgement of all the veins of the neck, and nothing tends so much to favour a return of venous blood, and a quiescent state of the parts, as a free passage of air into the trachea. As soon as the trachea is divided, the chin should be approximated towards the chest, and the edges of the wound held asunder by sharp hooks; by these means the escape of any foreign substance will be facilitated; or in those cases where the trachea lies very deeply below the surface, as in thick, short-necked people, the difficulty of keeping the edges of the tracheal wound separated may be obviated by passing a ligature through the edge of the wound on each side of the opening, when the operator can at will open or close the wound. If the chief object of the operation is to establish an artificial opening for respiration, an aperture sufficiently large should be made to introduce a curved silver canula, as in the operation of laryngotomy; or the Surgeon may remove a small segment of some of the tracheal rings: but the latter proceeding should never be adopted unless absolutely necessary, as there is some risk of the trachea contracting after the operation. The canula used should vary in size according to the age of the patient; as a general rule, both apertures in it should be sufficiently large to admit as much air as would pass through the rima in health; the tube should be of nearly uniform diameter throughout, slightly curved, and should fit pretty accurately in the opening in the trachea; this prevents the entrance of blood into the tube; if, however, too much pressure exists either on the margins of the opening, or upon the lining membrane of the trachea, ulceration may be produced.* A double canula should always be used; the inner one, which slightly projects at its lower extremity, should be withdrawn from time to time, to clear it of any mucus or blood that may accumulate in it. The tube is retained in its position by tapes passed through a ring on each side of the canula, and fastened behind the neck. Some very practical suggestions upon the kind of canula to be used in this operation are made by Dr. Fuller.* The canulæ generally sold by instrument-makers are not large enough to admit sufficient air for respiration: it must be obvious that as much air should pass through the artificial opening as ordinarily passes through the rima in health; but this cannot take place by means of the tubes in ordinary use. In some of the canulæ made, the shape of which, being conical, is well adapted for their passage into the trachea, the upper opening is sufficiently large, but the lower one is contracted to at least a third of the size of the upper one, and consequently can admit of only a very small amount of air. In the curved cylindrical canula, also in common use, it is true that the opening is of the same size at both ends of the tube, but the diameter of the tube of the largest size is not half the size of the rima during inspiration. One of the best canulæ at present in use is that invented by Dr. Fuller; it consists of a bivalve tube, so made that it may be introduced closed, the blades being expanded by means of a spring as soon as its insertion is effected. The shape of the instrument is such as to readily allow of its admission; its size when opened, large enough to permit a free passage of air; and it is so constructed as to prevent obstruction from mucus,—a frequent occurrence with those in common use.

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* Mr. John Wood has recorded a case of tracheotomy, in which "the tracheotomy tube in respiration had caused an ulceration downward, reaching at length the coats of the innominate artery, into which a small opening had formed, producing fatal hæmorrhage." *Trans. Path. Soc. Lond.* vol. xi. p. 20.

The dangers attendant upon the operation of tracheotomy have led some Surgeons to propose other situations for its performance, and instruments of various kinds have been devised to render it more easy and safe.

Laryngo-tracheotomy is that modification of the operation which consists in opening the air-passage between the cricoid cartilage and the isthmus of the thyroid gland. Anatomically considered, this operation is as dangerous as that of tracheotomy, on account of the large transverse communicating branches between the thyroid veins covering the spot, whilst the interspace between the cricoid cartilage and the isthmus of the thyroid gland is so small that an opening of sufficient size cannot be made either to introduce a tube sufficiently large, or to allow of the exit of any foreign substance from the trachea; and if the aperture is enlarged by extending the wound downwards, the isthmus of the thyroid can hardly fail to be divided, by which great hæmorrhage may be produced.

An instrument, called the tracheotome, has been invented, for the more easy performance of the operation of tracheotomy, and to obviate the danger caused by the passage of blood into the trachea during this operation. It consists of a curved trocar and canula, which is intended to be thrust into the air-passage at the point selected by the operator, after the usual preliminary incisions have been made to expose the trachea. Besides the great inconvenience of the instrument, and the danger attendant on its use, especially in children, it is quite inapplicable in cases of croup, and in retention of a foreign substance in the air-passage, and does not in all cases prevent, when used, the occurrence of hæmorrhage into the trachea. It cannot, therefore, be recommended as a substitute for the operations above described. Another instrument has been invented, by Mr. Henry Thompson, consisting of two blades connected together at one extremity by a hinge, and capable of being accurately closed or separated by a screw. At one end the blades are bent down at an angle, provided with sharp cutting edges, and so constructed that, when closed, they form merely a single edge. When the instrument is used, the blades are closed, and the cutting point is introduced transversely into the windpipe, between the first and second rings of the trachea, the exact position of this part having been previously ascertained with the finger; then the blades are opened, by a screw, a sufficient extent to admit the canula. When this has been introduced, the blades are withdrawn. I have never seen this instrument used, and it appears quite inapplicable in many cases in which tracheotomy is necessary.

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* See his valuable paper on "Tracheotomy in Croup," *Med.-Chir. Trans.* vol. xl. p. 39.

The after-treatment to be adopted, after opening the air-passage, is of even greater importance than the operation itself. The patient should be placed in a room the temperature of which is warm and equable, and every means should be adopted to ward off inflammation of the air-passages; an occurrence not unlikely to be produced from the introduction of cold air into the trachea. In the Hospital for Sick Children, the inhalation of the vapour of steam is used with much benefit. The bed is surrounded with curtains or blankets, and a jet of steam admitted from the end of a tube connected with a tea-kettle. The general treatment must vary according to the nature of the injury or disease for which the operation is performed. It should be remembered, that in all cases these operations are had recourse to to facilitate respiration, and to afford time for the exhibition of the remedies most calculated to promote recovery. An experienced nurse, or assistant, should remain constantly at the bedside of the patient, to remove any mucus or blood that may from time to time obstruct the canula. If this substance is allowed to accumulate in the tube, and no one is at hand to remove it, the patient runs imminent risk of suffocation. If a double canula is used from the first, the inner one may occasionally be withdrawn and cleaned. If a single one is used, it may be kept pervious by passing through it, from time to time, a feather, or a probe armed at its extremity with a piece of lint or sponge. In most cases, after the operation, a copious secretion of viscid mucus takes place; this accumulates in the trachea, and, the patient being unable to expectorate easily, the end of the canula may at any moment become obstructed; and this is especially liable to occur during the first few hours after the operation; and if it happens when the patient is asleep, and carelessly watched, he may die suffocated. When the patient wishes to cough or speak, he should be instructed to draw in a full breath, and then close the orifice of the tube with his finger; expectoration can then be easily performed, and the voice may be heard, though not very audible.

When the disease or injury for which the operation is performed is cured, and when free respiration is established through the natural channel, the tube may be withdrawn, and the wound in the trachea closed. But it occasionally happens that normal respiration can never be reëstablished; it then becomes necessary to wear a tube for the remainder of life. The tube may then be provided with a valve, opening inwards, which admits of the patient breathing through the tube, and expiring by the glottis; by this means he is able to speak as well as before the operation. It is necessary to withdraw the tube occasionally, in order to keep it clean, or it may become corroded, and fall into the trachea. A case is mentioned by Mr. South,* of a man in whom a tube had been introduced two years and a half previously; the tube became corroded; the part within the windpipe falling into the trachea, and nearly suffocating the patient. It was, however, ultimately expelled in a violent fit of expectoration, when the patient experienced immediate relief.

When the tube has been worn for a considerable time, the cavity of the larynx becomes so much contracted, that it is necessary, in many cases, if not in all, for respiration to be carried on through the artificial opening. In the Museum of St. Bartholomew's Hospital,† may be seen the larynx and trachea of a man on whom the operation of tracheotomy was performed twelve years before death; the patient continuing to the time of his death to breathe through a canula passed through the opening made in the operation. The orifice in the trachea is situated immediately below the cricoid cartilage. The rima glottidis is almost closed by the thickening and contraction of the mucous membrane lining the larynx. The chordæ vocales are also so much shortened that the arytænoid cartilages are within a quarter of an inch of the angle of the thyroid cartilage.

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* *Chelius's Surgery*, vol. ii. p. 400.

† Series xxv. no. 12.

Opening the air-passage may be required in any case of disease or injury which produces mechanical impediment to the passage of air from the mouth into the trachea; in cases of foreign substances in the air-passages; and in some cases of suspended animation, where artificial inflation of the lungs cannot be performed by the ordinary means.

When a foreign body is lodged in the air-passages, an operation for its immediate removal is imperatively demanded. The situation of the incisions will depend upon the site of the intruding substance; laryngotomy being selected if it is impacted in the glottis; tracheotomy, if the foreign substance is lodged in the trachea or bronchus.

In spasm of the glottis, the Surgeon is frequently compelled to open the air-passage, and laryngotomy may be selected as the easier operation. Temporary occlusion of the glottis from spasm may be produced from various causes; it frequently follows a blow upon the larynx; it may be induced by the impaction of a foreign substance in the pharynx, or upper part of the œsophagus; or from the pressure of a tumour upon the nerves of the larynx, as in some cases of aortic aneurism, where the tumour implicates the recurrent laryngeal nerve, producing violent paroxysms of spasm, and threatening suffocation. Tracheotomy has been proposed as a palliative in cases of hydrophobia attended with much suffocative spasm of the laryngeal muscles. It has also been performed in some cases to relieve urgent dyspnœa and suffocative spasm, occasionally present in cases of tetanus; and it has been frequently had recourse to since first recommended by Dr. Marshall Hall, in the severer forms of epilepsy, attended with spasmodic closure of the glottis, and imminent risk to the patient's life.

In cut throat, tracheotomy is not unfrequently imperatively demanded, in those cases where œdema of the glottis has supervened, or where infiltration in the neighbourhood of the larynx is so great as to threaten suffocation.

In inflammation with œdema of the cellular tissue of the larynx, produced by the inhalation of flame, or from the attempt to swallow boiling water, the mineral acids, or any other corrosive poison, or in the œdema of the mouth, fauces, and glottis, which occasionally attends the exhibition of mercury, laryngotomy is often necessary, if other means fail to afford relief.

In some cases of fracture of the hyoid bone, with displacement of the fragments, and in cases of fracture or wounds of the cartilages of the larynx, opening the air-passage is frequently absolutely necessary.

In inflammation of the tongue, in tonsillitis, and pharyngitis, where the œdema is so great as to produce symptoms of suffocation, it may be necessary to have recourse to laryngotomy.

In acute œdema of the larynx, if other remedies fail, and the symptoms of suffocation become at all urgent, laryngotomy should be performed.

In acute laryngitis, croup, and diphtheria, tracheotomy is often necessary, to relieve the urgent symptoms of suffocation; thus affording a longer time for the exhibition of remedies calculated to allay the disease, and, at the same time, furnishing a ready exit for flakes of false membrane, that could not pass through the rima glottidis.

In chronic inflammation and ulceration of the larynx, whether from syphilitic disease or phthisis, threatening suffocation may be induced at any moment, from acute œdema, or from spasm of the glottis; or life may be exhausted more gradually by constant dyspnœa, spasmodic cough, and purulent expectoration. In these cases, whenever the difficulty of breathing is so great as to threaten suffocation, tracheotomy should be performed. In many cases, although the ultimate recovery of the patient is hopeless, this operation affords much relief, and life is not unfrequently greatly prolonged.

In necrosis of the laryngeal cartilages, accompanied not unfrequently with abscess around the larynx, tracheotomy is occasionally required, to save life from threatened suffocation.

Pressure on any part of the larynx or trachea may induce threatened suffocation, either by directly occluding the passage for the transmission of air, or by exciting spasm of the muscles of the glottis. If produced by an abscess in the neighbourhood of these parts, the abscess should be opened; if from diffuse inflammation of the areolar tissue of the neck, relief may be obtained by free incisions; if from the presence of a tumour, the tumour should, if possible, be removed; and if from an aneurism, ligature of the artery may be had recourse to: if, however, it is impossible to remove the obstruction, as, for instance, where compression of the trachea exists from bronchocele, tracheotomy must be had recourse to, if it can be performed below the part where the obstruction exists.

In tumours, warty growths, and epithelioma of the larynx, tracheotomy may be performed with considerable benefit to the patient, whenever life is threatened by suffocation.

FOREIGN BODIES IN THE PHARYNX.

Foreign bodies of various kinds are frequently impacted in some part of the pharynx: where these are thin and pointed, such as pins, needles, fish-bones, bristles, &c., they most frequently become entangled between the folds of the soft palate, or in the mucous folds connecting the base of the tongue with the epiglottis; where the foreign substance is more bulky, such as a portion of food, or a piece of money, it becomes arrested in the lowest, because the narrowest, part of the pharynx.

However small the foreign substance may be, much discomfort is produced until it is removed. If the body is small, pointed, and retained between the folds of the soft palate, the patient probably complains of a local painful sensation, accompanied in some cases with difficulty in swallowing, disposition to vomit, and occasional spasmodic contraction of the pharynx and œsophagus. If the foreign substance should have penetrated the mucous membrane at the root of the tongue, near the upper orifice of the larynx, in addition to the above symptoms, cough, with difficulty of breathing, sooner or later supervenes. An interesting case is related by Mr. South,* showing the severe symptoms produced by the retention of a foreign body in this situation, and the necessity of a careful examination for its detection. A lady, in swallowing a morsel of food, felt a sharp substance become lodged in her throat, which produced a constant pricking, and in the course of a few hours, cough, and repeated attempts at deglutition. She was examined shortly after by a medical man, who, finding nothing, considered it merely a case of local irritation, and treated it accordingly. In twenty-four hours the symptoms became aggravated to such an extent as to threaten immediate suffocation; and when seen by Mr. Tunaley, it was necessary at once to perform tracheotomy. Subsequently an examination of the mouth was made with the finger, when there could be felt, when an attempt to swallow was made, the point of what was taken for a pin. A pair of dressing forceps, bent for the purpose, and passed into the throat, removed this, and it proved to be a bristle, about an inch in length, which he considers had penetrated the mucous membrane at the root of the epiglottis, and, by its continued irritation, had produced spasm of the glottis.

Foreign bodies of large size are generally arrested at the lowest part of the pharynx, just where this sac becomes continuous with the œsophagus, and usually give rise to much distress, from pressing upon, or irritating, the upper end of the larynx, producing a sense of choking, fits of suffocating cough, and constant disposition to vomit. Foreign substances in this situation may prove fatal in a very short time, from spasm of the glottis, or by compressing the windpipe; their long-continued presence may produce inflammation and suppuration; or their extreme pressure may give rise to gangrene and perforation of the part. In some cases death occurs so suddenly that the patient is supposed to have died from apoplexy. Mr. South narrates a case, in which he examined the body of a man who was brought to the hospital, and was supposed to have died of apoplexy. On accidentally removing the tongue, pharynx, and neighbouring parts, an enormous lump of beef was found completely filling up the whole pharynx, and compressing the epiglottis. It was ascertained that, whilst eating soup for his supper, he suddenly rose from the table, went out of doors, and shortly after was found dead near the threshold. A remarkable instance of the arrest of a foreign substance in the pharynx is narrated by the same author, occurring twice in the same person, who, had he not been a medical man, would probably have been suffocated before assistance could have been obtained. In eating his breakfast quickly, he suddenly felt choked, could not swallow the morsel in his throat, and could not breathe; he thrust his fingers back to try and pull out the morsel of food, in which he succeeded, and found that the small portion of meat swallowed was attached by a thread of cellular tissue to another portion, which had become entangled in his teeth, and the thread had pressed down the epiglottis, so that every effort to swallow made him still worse. The same accident occurred a second time, but was in the same way relieved.

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* *Chelius's Surgery*, vol. ii. p. 384.

When called to a patient, suffering from the retention of a foreign body in the pharynx, the Surgeon should place him in a chair opposite a good light, with the mouth widely opened; the finger should be passed into the pharynx, and careful search made for the foreign body. If the latter is small and pointed, the tongue should be depressed, and the patient made to inspire deeply, by which the pillars of the fauces are raised and widely separated; when, not unfrequently, the extraneous substance may be detected projecting from between the folds of the soft palate, and it may be removed with the finger-nail, or with a pair of dressing forceps. Violent retching is not unlikely to be produced by these measures, but this is of little consequence; and if the foreign substance is large and fixed in the lower part of the pharynx, this act may assist its expulsion. If imminent suffocation is present, and the extraneous substance so impacted as to be incapable of extraction, laryngotomy should be at once performed. This operation was successfully had recourse to by Habicot,[*] as detailed in a case previously referred to.

It frequently happens that the painful sensation of a foreign body remains after the substance has been removed, or has passed into the stomach; but cases have occurred in which a foreign substance has been extracted, yet the symptoms still continued, and were not relieved until the removal of a second substance, which for a time had escaped notice.

A foreign body may remain impacted in the pharynx for a considerable period. A case is recorded by Dr. Ogier Ward,[†] where a halfpenny was impacted in the pharynx of a child for eight months. His mother stated that she supposed he swallowed a halfpenny with which he was playing, as he began to choke immediately, and the coin could not be found, and from that moment his breathing was stridulous. He constantly dribbled a thick mucus, and could only suck one mouthful of milk at a time, being forced to withdraw from the breast at each effort of swallowing. These symptoms, together with cough, continued for eight months, when one morning his mother brought him, looking comparatively well, and produced the halfpenny, which she said he had taken out of his mouth, and put in his father's hand, after a severe fit of coughing the day before. The halfpenny was much worn and corroded, and covered with a thick coating of dried mucus or masticated food. From this ime the patient gradually improved. Monro mentions a case in which an extraneous substance, detained at the origin of the gullet, became lodged in a sac of some length, which descended behind the œsophagus; and Rokitansky[‡] remarks that "sometimes small hard bodies, such as cherry-stones, give rise to serious occurrences, by causing at different parts of the œsophagus, but chiefly at the lower constrictor of the pharynx, the formation of diverticula."

Foreign Bodies in the Œsophagus.

The peculiar function of the œsophagus renders it extremely probable that a solid substance may be retained in it during its passage from the pharynx into the stomach; and although a foreign body may become fixed in any part of this tube, its lodgment is usually effected either at its commencement, opposite the cricoid cartilage, or at the lower end, just above the diaphragm, as it is in these situations that the tube is narrowest.

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[*] *Mém. de l'Acad. de Chirurgie*, t. xii. p. 243.

[†] *Path. Trans. Lond.* 1848-49.

[‡] *Pathological Anatomy*, vol. ii. p. 12.

The substances which have been retained in this tube are very various: articles of food, such as pieces of crust or imperfectly chewed meat, portions of bone, pieces of money, stones, pins, needles, buttons, knives, forks, scissors, spoons, keys, a chestnut, a small apple, a fish-hook, artificial teeth, the handle of a punch-ladle.

The symptoms and ultimate effects produced by the retention of a foreign body in the œsophagus vary, according to its size, shape, and situation.

If the foreign body is small, it may produce simple irritation, with more or less dysphagia. Its long-continued presence may excite inflammation of the œsophagus, which may gradually advance to suppuration and ulceration. In the museum of St. George's Hospital is part of the œsophagus of a dog, showing a large piece of bone impacted in its walls, which had produced ulceration and partial sloughing, and subsequently extensive suppuration in the mediastinal, and the pleural and pericardial cavities. The bone had apparently been swallowed along with other food, and had become fixed in the situation above mentioned. In the same museum is a specimen, from a case recorded by Dr. J. W. Ogle,* in which the arrest of a portion of bone in the œsophagus was followed by ulceration of an intervertebral substance, and disease of the spinal cord; and Dr. Duncan of Edinburgh† has related a case in which the sharp points of the metallic setting of some false teeth, arrested in the œsophagus, caused ulceration of the tube, which opened into the arch of the aorta, and produced fatal hæmorrhage.

When the foreign substance is small, pointed, and sharp, such as a nail, pin, or needle, it may perforate the mucous membrane, and be so firmly retained there as to be incapable of removal: or it may pierce the œsophagus, and subsequently approach the aorta or trachea,‡ or it may travel to different parts of the body, approaching the surface in a remote situation, after the lapse of months or years, where an abscess may form, out of which it is discharged. In some cases the foreign substance becomes loosened by ulceration of the adjoining part of the tube, and is either got rid of by vomiting, or descends into the stomach, when it is voided with the fæces.

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* *Path. Trans. Lond.* vol. iv. p. 27.

† *Northern Journal of Medicine.* May 1844.

‡ Rokitansky, *Path. Anat.*, vol. ii. p. 12.

If the foreign body is of large size, and is retained in the upper part of the tube, its pressure on the trachea may endanger life by producing suffocation.

Notwithstanding the great danger which may follow the retention of foreign substances in this tube, cases have occurred in which they have remained a considerable time without producing any mischief. In the museum of the College of Surgeons* is the whalebone handle of a punch-ladle, from Mr. Heaviside's collection, which a gentleman, who was insane, had rammed down his throat, with an intent to destroy himself. It was extracted, after it had been in his throat sixty-two hours, without producing any mischief, he having eat, drunk, and slept, as usual, during the whole time, and being next day free from complaint. Monro mentions the case of a boy, who had attempted to swallow a halfpenny; it remained in his œsophagus three years; and possibly it might have remained there a much longer period, had he not been seized with consumption, which proved fatal. Upon examination, the gullet was found closely embracing the halfpenny, and considerably expanded by it. Another case is also related by the same author, in which a halfpenny was impacted in the gullet for six months, and was afterwards extracted by Monro's father with a blunt hook.

The diagnosis of a foreign body in the œsophagus is often attended with difficulty. If the foreign substance is of large size, and remains impacted in the upper part of the tube, it may be felt on external examination; or if the mouth is opened, and the tongue depressed, it may be detected by exploring the tube with he finger, or on attempting to pass a whalebone or elastic sound. Cases, however, have occurred in which a foreign substance, although resent, could not be detected, after repeated and careful instrumental examination; but the proof of its existence has been shown y its having been subsequently got rid of by other means; and uch local pain may be complained of, deglutition may be difficult nd painful, and even respiration interfered with, without a foreign ody being present; the symptoms being the result of swallowing body of large size and irregular surface, which in its descent produces abrasion of the mucous membrane of the tube, and subsequent inflammation.

When a foreign body is impacted in the œsophagus, it should be removed as speedily as possible; but the mode in which this must be attempted will depend a good deal upon the nature of the extraneous substance, its size, and the position it occupies in the canal. If it is a small piece of bone, for instance, it may sometimes be got rid of by making the patient swallow a good mouthful of bread; and this easy mode of treatment is sometimes successful, when other means have failed. In the museum of St. George's Hospital is a small portion of bone, which was supposed to have been swallowed by a man about three weeks previous to his admission, and was suspected, from his sensations, to have lodged in the œsophagus. A probang was passed the day after he had swallowed the bone, but without relief, and again at the end of a fortnight. Previous to this latter exploration, he had only been able to swallow fluids, but afterwards he could eat small pieces of food. On his admission, the chief pain was just above the sternum, where an imperfect sensation of the bone was felt. Bougies and forceps of various sizes were introduced two days after his admission, but they passed beyond the bone to the stomach. On the evening of the eleventh day after his admission, whilst taking his tea, the patient endeavoured to swallow a large piece of crust, and in this effort he felt the bone dislodged and enter the stomach. He was ordered some castor oil, and on the following day he produced the portion of bone, which had passed per rectum.

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* *Pathological Catalogue*, vol. iii. p. 28.

If the extraneous substance is of moderate size, and its nature such that it can be easily digested, or is not likely to be hurtful to the stomach or the intestinal canal, during its passage through it, it may be pushed gently into the stomach with a flexible probang, fifteen or sixteen inches long, to the end of which a portion of sponge should be carefully fastened. But if the foreign substance is situated at the upper part of the canal, attempts should first be made to remove it by the finger, or with long curved forceps, in order to avoid the risk of injuring the mucous lining of the œsophagus, which a probang pressing a foreign substance in front of it is likely to do. A foreign substance also in this situation may sometimes be displaced, and subsequently removed, by making gentle pressure with the finger upon the side of the neck opposite the impacted substance.

If the foreign body is of large size and hard, and its surfaces rough and angular, such as pieces of glass, stones, pieces of bone of large size, they should always be extracted, if possible. The patient should be seated in a chair, and the head thrown well back and supported in that position by an assistant; the tongue being depressed, a pair of curved forceps, previously oiled, should be passed into the back part of the pharynx, and directed gently along the œsophagus until the foreign body is approached. The Surgeon should then seize it if possible, and, its dislodgment being effected by cautious movement of the instrument, it should be extracted. The forceps used in this operation are of two kinds: in one the blades open in the lateral, in the other in the antero-posterior direction. The edges of the blades should be rounded off, so that when closed they do not injure the neighbouring soft parts; and the joint of the instrument should be covered by a sheath of elastic gum or gutta percha. The surfaces of the blades which come in contact are roughened, and well adapted to securely hold foreign bodies of a narrow spiculated form.

Small pointed bodies, such as pins, needles, fish-bones, nails, &c., may be removed occasionally by a flexible sound, to the extremity of which is attached a skein of thread, so as to form an infinite number of nooses in which the foreign substance may become entangled. Or a probang, to which a piece of dry sponge is fastened, has sometimes been successfully used in the extraction of similar substances. Flattened bodies, such as pieces of money, may be removed by a flat blunt hook.

Vomiting may be produced if the stomach is full, and no other means are at hand, in the hope that when the contents of the stomach are ejected the foreign substance may be displaced, and finally expelled. It appears that this treatment is rarely successful: if the foreign body is of large size, firmly impacted, and its surface rough and pointed, continued vomiting is not unlikely to be attended with laceration of the tube, and would certainly produce extreme pain and subsequent inflammation; and if the body is small and pointed, vomiting is likely to make it more firmly fixed. Two cases have, however, been recorded, in which large portions of tough meat impacted in the pharynx, and producing urgent symptoms of suffocation, were got rid of by injecting a solution of tartarised antimony into a vein of the arm.* Two other cases are noticed, in which peach-stones were removed from the pharynx by making the patients swallow a solution of tartarised antimony;† and one is recorded by Dr. Bond of Philadelphia,‡ in which part of the clavicle of a chicken was removed by exhibiting sulphate of zinc.

A dilute solution of one of the mineral acids may be exhibited where a small bone is lodged in the œsophagus, and cannot be got rid of by other means. This mode of treatment was first adopted by Professor W. Hall of Baltimore, who observes, "When a small bone is lodged in the fauces or œsophagus, it may be decomposed, or rendered so flexible that it will pass into the stomach by the patient frequently taking diluted mineral acids. They should be taken through a tube, to prevent their action upon the teeth. The strength of the acid should be accommodated to the sensibility of the parts over which it must pass. By this means I have succeeded in removing a small chicken-bone from the œsophagus, across which it had remained firmly fixed for several hours, although an emetic had been administered, and the curved forceps and probang had been frequently used, without success."

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* *Dict. des Sciences Méd.* tom. vii. pp. 21, 22.

† Dorsey's *Surgery*.

‡ Cooper's *Dictionary*, 7th ed., p. 1026.

When a foreign body is lodged in the œsophagus, and respiration so much obstructed from its pressure on the trachea that the life of the patient is endangered, tracheotomy must be performed, and the foreign substance subsequently removed.

It sometimes happens that all means for its removal fail; the foreign substance can neither be extracted, nor pushed downwards, nor got rid of by vomiting, or other means. Under these circumstances, if it is situated in the cervical portion of the tube, it should be at once extracted by operation. Some of the cases here related certainly show that extraneous substances may remain in the œsophagus for a considerable period without producing much distress to the patient, or injury to the neighbouring parts; but the result of other cases has shown that extensive suppuration and ulceration of the tube and of the neighbouring parts does occasionally ensue, and is frequently attended with fatal results. Under all circumstances, then, where the foreign body remains fixed in the cervical part of the tube, and cannot be removed by ordinary means, œsophagotomy is justifiable. Mr. Arnott's observations on this point are of great practical value.* "The rule of practice," he says, "ought to be, when a solid substance, though only of moderate size and irregular shape, has become fixed at the commencement of the œsophagus, or low in the pharynx, and has resisted a fair trial for its extraction or displacement, that its removal should at once be effected by incision, although no urgent symptoms may be present. I insist the more upon this point, because I have reason to believe that the operation has been, in several instances, omitted when it ought to have been performed, chiefly from its supposed danger and difficulty, but also from a reliance on the powers of nature. I have particularised the low situation of the substance as a reason against unnecessary delay, because great difficulty is experienced in seizing it when so placed, and the attempts will, I believe, usually fail." Mr. Cock* considers that "a foreign body might be extracted from any portion of the cervical gullet, including a range, commencing above from that point of the pharynx which may be inaccessible from the mouth, and terminating below at the upper opening of the chest. It might even be possible to extract a foreign body from the early thoracic portion of the œsophagus, provided that it could be reached with the finger, and thus brought under the influence of a pair of curved forceps."

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* *Med.-Chir. Trans.* vol. xviii. p. 93.

Œsophagotomy. The side of the neck on which the operation is to be performed, and the exact situation of the incision, will depend upon circumstances. If the foreign substance should project externally, or can be detected with the finger on examining the œsophagus from the mouth, the incision should be made on the corresponding side, and directly over the projection. If, however, it cannot be decided upon which side the foreign substance is impacted, the left side of the neck should be chosen to perform the operation, as the œsophagus in its descent between the trachea and the spine inclines rather to the left side, and that side of the neck is the most favourable for the manipulation of the Surgeon. The patient being placed upon his back, with the head and shoulders slightly elevated, an incision about four inches in length should be made in the depression between the sterno-mastoid muscle on the outer, and the larynx and trachea on the inner side; and this incision should extend from the upper border of the thyroid cartilage downwards, the skin, platysma, and fasciæ only being divided. The edges of the wound being separated, the omo-hyoid muscle should be drawn inwards, and the fibres of the sterno-hyoid and sterno-thyroid muscles, if necessary, divided across. The sheath of the carotid vessels, being now fully exposed, should be drawn outwards, together with the sterno-mastoid, and retained in that position by retractors. The thyroid gland must be drawn inwards with a blunt hook, the more complete separation of these parts being effected with the handle of the scalpel and the fingers. The larynx should now be turned slightly upon its axis, and, the finger being placed behind it, careful search may be made to detect the situation of the foreign body. If it cannot be felt, a male catheter should be passed from the mouth into the pharynx, and be made to project into the wound, the wall of the tube being pressed before it. The œsophagus having been divided to a small extent, a pair of common dressing or polypus forceps may be introduced, and the blades opened to a sufficient extent to allow of the introduction of the finger through the wound; by this means of dilating the opening, hæmorrhage is avoided. The foreign body having been detected, it should be seized with forceps and carefully withdrawn. In the removal of a foreign substance from the lower end of the pharynx, or upper part of the œsophagus, the incision should always be limited above to the upper border of the thyroid cartilage; otherwise the superior laryngeal nerve and vessels, the hypoglossal nerve and lingual vessels, and the superior thyroid vessels, are in danger of being wounded: below, the incision should be limited to within an inch and a half of the sterno-clavicular articulation, as the inferior thyroid vessels may be otherwise endangered. If any small arteries are divided during the operation, they should be tied at once, otherwise the operator may be embarrassed; and in the latter part of the operation, care must be taken to avoid the recurrent laryngeal nerve, which ascends in the interval between the trachea and œsophagus,—if this nerve is injured, loss of voice may be permanent. In a case recorded by Mr. Cock, the operation was followed by a very decided permanent alteration in the voice, the patient at first speaking in a hoarse, husky whisper: and a year afterwards, the voice had not regained its usual character. These symptoms, the operator infers, were owing to the division of those filaments of the recurrent laryngeal nerve which supply the arytænoid muscle, and which correspond with the track of the knife, when the pharynx was opened. After the operation, an elastic gum catheter should be passed from the mouth into the œsophagus, and all food or medicines may be directed into the stomach through it. In a few days, the common œsophagus-tube may be used; by this means the healing of the wound is not retarded. In Mr. Cock's case, the use of the feeding-tube was abandoned three weeks after the operation, the patient being able to swallow with facility.

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* *Guy's Hospital Reports*, vol. iv., 1858.

Œsophagotomy has been resorted to only in a few instances. Mr. Cock gives the records of seven cases in which the gullet has been opened to extract a foreign body; in two of these the operation was attended with a fatal result, in five it was successful. These cases, together with Mr. Cock's, are appended in a tabular form.

TABLE OF CASES

In which the Operation of Œsophagotomy has been performed.

No & Date.	Sex	Æt.	Nature of Foreign Body.	Point of Impaction.	Treatment before Operation.	Operation when performed.	Result.	Cause of Death.	Operator.
1. 1738	M.		Portion of bone, one inch long, six lines broad.	Œsophagus: exact point not stated.	Not mentioned.	Operation performed, and foreign body extracted.	Recovered.		M. Goursauld.
2.			Probably a portion of bone.			Operation performed.	Recovered.		M. Roland.[1]
3. 18 2.	M.		Portion of beef-bone.	In œsophagus at lower part of neck.	Attempts made to dislodge it.	Operation on twelfth day after accident; bone extracted with difficulty, on left side of neck.	Speedy recovery.		M. Begin.[2]
4. 18 2.	M.		Large conical fragment of bone.	Œsophagus; lower part of cervical portion.	Every means attempted to dislodge it.	Operation on eighth day after accident, on left side of neck.	Recovered.		M. Begin.[3]
5. 1833.		2½	Spinous process of one of the dorsal vertebræ of a sheep.	Lower part of pharynx.	Emetics, and various attempts to dislodge it.	Operation not allowed until five weeks after impaction; incision on right side.	Death, fifty-six hours after operation.	Pneumonia, which existed at time of operation.	Mr. Arnott.[4]
6. 1845.	M.		Portion of bone.	Could be felt from the exterior, projecting above the clavicle.	Bleeding, injection of tartar emetic in veins, enemata of belladonna, and sixty attempts at dislodgement by various instruments.	Operation four days after impaction; bone swallowed by patient during its performance.	Death, two days after the operation.	Collapse. Pharynx gangrenous. Stomach and duodenum inflamed	Dr. Martini.
7. 1845			Large portion of bone.	Œsophagus.	Repeated attempts to dislodge it, which produced severe injury, and ultimately ulceration of gullet.	Operation eighth day after accident; incision on left side.	Recovery by the twenty-sixth day.		M. Delarocherie.[5]
8. 1856.	M.		Gold tooth-plate, containing a false incisor tooth.	At junction of pharynx with œsophagus. No external projection.	Attempts at removal with forceps, and subsequently with other instruments; and emetics.	Operation on fourth day after accident; incision on left side.	Complete recovery four weeks afterwards, but with decided permanent alteration of voice.		Mr. Cock.[6]

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[1] *Journal Hebdomadaire* for 1838.

[2] *Ibid.*

[3] *Ibid.*

[4] *Med.-Chir. Trans.*, vol. xviii.

[5] *Journal de Chirurgie*, Nov. 1845. p. 337.

[6] *Guy's Hosp Reports*, vol. iv. 1858.

INJURY OF THE PHARYNX AND ŒSOPHAGUS FROM DRINKING THE CONCENTRATED ACIDS OR OTHER IRRITANT FLUIDS.

The immediate effects of swallowing the concentrated acids or caustic alkalies is to produce, either entire destruction or intense inflammation of the lining membrane of the pharynx, œsophagus, and stomach. In most of these cases death takes place in from eighteen to twenty-four hours afterwards, on account of the mischief produced by the contact of the poison with the neighbouring parts, or more distant organs; and if the patient recovers from the immediate effects of the injury, extensive ulceration, followed by contraction of the walls of the œsophagus, not unfrequently occurs; the patient dying, after an interval of several weeks or months, of inanition. When the concentrated mineral acids are swallowed, the effects produced on the pharynx and œsophagus vary, in different cases; and this probably depends upon the strength of the fluid, the quantity swallowed, and the condition of the stomach, as to its being full or empty, in each case. In some cases, the destruction of the lining membrane of the gullet and stomach is so complete, that the patient dies from collapse in a few hours. In other cases, the patient recovers from the immediate effects of the injury, suffers for a long time with very severe and protracted symptoms, resembling those of stricture of the œsophagus, and finally recovers; whilst, in other cases, the latter symptoms continue unrelieved, and he dies exhausted. As soon as the poison has been swallowed, the patient complains of a violent burning pain in the fauces, œsophagus, and stomach. The lips and fauces are corroded, and much ropy mucus exudes from the mouth; vomiting comes on, is usually incessant, and is reëxcited as soon as any thing is taken; the ejected matters being viscid, and of a dark coffee-ground colour. The patient is generally unable to speak or swallow, and not unfrequently there is extreme difficulty of breathing, from swelling of the fauces and larynx. The pulse is almost imperceptible, the extremities cold, there is great thirst, and obstinate constipation; and if any evacuations take place, they are usually of a very dark brown or black colour, from admixture with altered blood. These symptoms are soon followed by exhaustion. After death, the lips are found excoriated, and the lining membrane of the mouth white, softened, and corroded: the mucous membrane of the fauces and œsophagus is corroded, and of a brownish or ash-gray colour, sometimes black and charred in spots and patches. The stomach is not unfrequently covered with a black pitch-like substance, which, when removed, shows the lining membrane intensely inflamed. Sometimes the coats of the stomach are softened and perforated. In the case of a man,* who died on the fourth day after swallowing about a dessert-spoonful of oil of vitriol, the walls of the œsophagus were swollen to three times their natural thickness. This was due to a sero-albuminous exudation in the submucous tissue. The mucous membrane of the stomach was only affected to any extent at the pyloric half of the organ, where the interior was of a black colour, and raised up in large projecting masses, which were in a sloughing condition; the whole coats of the stomach were soft, and readily tore. And in the case of a woman,† who died eleven days after drinking nearly three ounces of dilute sulphuric acid, the mucous membrane of the œsophagus was inflamed, and its surface covered with lymph; the mucous membrane covering the greater part of the stomach was quite detached, having almost entirely sloughed off. In a fatal case, recorded by Mr. Porter, of a girl who had swallowed dilute sulphuric acid, "the sufferings of the patient were extreme, and very protracted. After the violence of the gastric symptoms had somewhat subsided, she was seized with symptoms resembling stricture of the œsophagus; no solid material could be swallowed, the attempt causing great pain; fluids, if taken cautiously, seemed to stop for some minutes in the œsophagus, and then passed the obstruction slowly; but if there was any unguarded haste, they were forcibly ejected through the mouth and nose. These symptoms were ultimately removed, but seven months elapsed before the patient could leave the hospital." Dr. Wilson‡ has recorded a case of poisoning by sulphuric acid, in which the patient lived forty-five weeks and three days. Six months after swallowing the acid, the patient ejected, during a violent fit of coughing, a cylindrical tube, eight or nine inches in length. After death, the lower two-thirds of the œsophagus were thickened and narrowed, its inner surface being very vascular, irregular, and softened; the upper third shining like an old cicatrix. The chief symptoms in this case, preceding the attack, which ended fatally, were, great difficulty in swallowing, pain extending from the pit of the stomach to the shoulders, expectoration, at intervals very copious, as much as two pints of frothy mucus being discharged in twenty-four hours.

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* *Guy's Hosp. Rep.* vol. v. 1859, p. 134.

† Op. cit. p. 181.

‡ *Med.-Chir. Trans.* vol. xxi.

Strong solutions of potash, soda, or ammonia, when taken in large quantities, may destroy life in a short time; but if the patient recovers from the immediate effects of the poison, intense inflammation of the lining membrane of the œsophagus and stomach may ensue, followed by ulceration and subsequent narrowing of the calibre of the œsophagus, the patient ultimately dying exhausted. The patient complains, immediately after swallowing the poison, of an acrid caustic taste; there is a burning sensation in the fauces, œsophagus, and stomach; vomiting sometimes occurs, the ejected matters being of a dark-brown colour, and mixed with blood; there is severe colicky pain in the abdomen; the surface is cold and clammy, the pulse quick and feeble; death occurs in a few hours, if the poison is taken in a concentrated form and in great quantity. In the case of a child, a year and a half old, who died about twelve hours after having drunk about a mouthful of soap-lees,* "the fauces, tonsils, and mucous membrane of the pharynx and œsophagus had a slightly swollen appearance, and presented a yellowish brown hue. The membrane was changed by the alkali, but was nowhere destroyed. The greatest pernicious effect had been produced at the end of the œsophagus, where the interior was of a dark-brown colour; this terminated at a definite line, the mucous membrane of the stomach being almost unaffected," excepting that it was more than usually injected, and near the pylorus were a few rugæ of a very dark-brown colour. The altered membrane could not be stripped off, and had a hard and horny feel. The following cases will serve to illustrate the symptoms produced where the patients recover from the immediate effects of the injury, and die from the secondary effects of the poison. A woman, æt. 44, was admitted into St. George's Hospital on May 2, 1853, about six hours and a half after swallowing a quantity of "American potash," probably a saturated solution of carbonate of potash. She had vomited directly after taking it. The mouth and fauces were much corroded: and on introducing the stomach-pump, some shreds of softened mucous membrane were found clinging to the tube. There was great pain in the fauces, œsophagus, and at the epigastrium, but no tenderness on pressure, and there was a little vomiting two days after her admission; deglutition was difficult, and pain was felt after the passage of food into the stomach. At the beginning of June, there was frequent vomiting, with pain in the abdomen, tenderness on pressure, and constipation. After a time, nothing could be retained in the stomach; food or medicine, after causing her much pain, was soon rejected, the patient, for a short time before death, being sustained only by nutritive enemata. She died of inanition, July 8th, about two months after taking the alkali. On inspection, there were found at the upper part of the œsophagus, opposite the cricoid cartilage, three dense cicatrised bands, contracting the mucous lining in that situation, apparently the result of previous ulceration. The lower part of the œsophagus was much contracted, the lining membrane entirely destroyed, and the muscular coat exposed. The external coats were much thickened. The cardiac orifice of the stomach, where the ulceration ceased, was so much contracted as hardly to admit of the passage of a director. At the pyloric end, the mucous lining presented a large and dense cicatrix, obstructing all communication with the duodenum, excepting by an orifice no larger than a probe. The intervening portion of the stomach was healthy—as were also the small and large intestines. Dr. Basham* has recorded a case of stricture of the œsophagus, fatal, two years and three months after accidentally swallowing soap-lees. This patient recovered from the first symptoms of irritation, and eleven months afterwards suffered from urgent dysphagia; the difficulty of swallowing having been felt slightly within a few weeks after taking the poison. In this case the stomach was unaffected.

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* *Guy's Hosp. Rep.* vol. v. p. 133, 1859.

A strong solution of ammonia, when swallowed, produces similar effects to those noticed above. A female, æt. 19, was admitted into Saint George's Hospital on September 2d, 1853, who, eight weeks before her admission, while in an unconscious state, was made to swallow a quantity of hartshorn. Immediately afterwards she felt severe pain in the stomach, and in an hour or two became sick and vomited some blood; hæmatemesis continuing for three days. From the first there was great irritability of the stomach, and constant rejection of food; the bowels were constipated; there was great emaciation and loss of strength. Ultimately she died of starvation, three months after swallowing the poison. On inspection, the œsophagus was healthy, excepting the cardiac orifice of this tube, which was slightly contracted. On the posterior wall of the stomach was a dense cicatrix of the size of half-a-crown, and from its margins fibrous bands diverged in various directions. The pyloric orifice was contracted to the size of a crow-quill. The other parts of the intestinal canal were healthy.

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* *Med.-Chir. Trans.* vol. xxxiii., where the author gives a short record of cases by Sir C. Bell, Mr. Cumin, and Mr. Dewar, in which fatal consequences ensued from swallowing this poison.

It thus appears that the concentrated acids and caustic alkalies, when swallowed, may produce, to a certain extent, a similar action upon the surfaces with which they come in contact. If the poison is taken in a large quantity and in a concentrated form, complete destruction of the mucous lining of the pharynx, œsophagus, and stomach ensues, and the latter organ, if empty, is not unfrequently perforated. If the poison is in a more diluted state, violent inflammation is excited in the fauces and œsophagus, followed by effusion of lymph on the surface of the mucous membrane, and in the submucous cellular tissue, producing much pain and great impediment to deglutition. Ulceration follows, with increased thickening of the walls of the œsophagus, and confirmed stricture of this tube; finally the œsophagus is completely obstructed, and the patient dies ultimately of starvation.

In the treatment of these cases the primary effects of the poison should, as far as possible, be prevented, by diluting the contents of the stomach and drawing them off by means of the stomach-pump, and by exhibiting the reagents most calculated to neutralise the poison. To allay inflammation of the gullet and stomach by the application of leeches, and by the exhibition of calomel with opium,—the latter remedy in large and frequent doses,—demulcent drinks may be given, with milk and farinaceous diet, and the bowels should be regulated by purgative enemata. When inflammation becomes more chronic, counter-irritation should be used; and when the inflammatory symptoms are to a certain extent controlled, and even before any signs of dysphagia appear, the œsophagus should be kept of uniform size by the daily introduction of an œsophageal bougie; and this treatment should be continued for several months, and long after there is any apparent necessity for it, in order to prevent the possibility of subsequent contraction.

In a case recorded by Mr. Cumin,* of stricture of the œsophagus from swallowing a strong ley of American potash, mistaken for treacle, the introduction of bougies was very successful, but required unremitted attention for ten months, to restore deglutition to its healthy condition. But cases may occur in which the early age of the patient would be an almost insurmountable obstacle to the daily introduction of a bougie, for the purpose of dilating the stricture;

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* In Dr. Basham's paper, *Med.-Chir. Trans.* vol. xxxiii.

or the patient may, for various reasons, have neglected to use those remedies; the stricture then becomes impassable, and the unfortunate sufferer dies literally starved, suffering for a long time before death all the torments of hunger, thirst, and exhaustion,—symptoms which are only very slightly alleviated by nutrient enemata, even if frequently administered. Under these circumstances, is the operation of gastrotomy justifiable?

A case has been recorded by Mr. Cooper Forster,* of contraction of the œsophagus from corrosive poison, in which the operation of gastrotomy was performed. A young child was admitted into Guy's Hospital on February 2d, under the care of Dr. Addison, having swallowed, seventeen weeks before admission, some corrosive poison, supposed to be a solution of potash. He was instantly seized with violent vomiting, and, either at the time or afterwards, the vomited matters contained two or three tea-spoonfuls of blood. Marked dysphagia came on fifteen weeks after swallowing the poison, which gradually increased in severity. The child complained, on admission, of much pain in the throat and epigastric region; he was then emaciated, and was chiefly supported by injections of beef-tea and wine. As the difficulty of deglutition had increased, and he was sinking fast, gastrotomy was performed; but he died three days afterwards from peritonitis, produced by the adhesions between the stomach and parietes giving way from sloughing of the external wound. On inspection it was found that a large part of the œsophagus was affected by the poison, but especially the middle, which was much constricted, although a narrow passage still existed through it. The stomach was found healthy.

It is evident that this child was dying from the result of a powerful escharotic applied to the œsophagus; this tube was daily becoming more obstructed from contraction, consequent on the injury; and it was manifest that, if no plan could be adopted to dilate it by mechanical means, the patient would die of starvation. Under circumstances similar to the above, where the patient is dying of starvation, where no possibility of dilating the stricture exists, either from the age of the patient, the density of the stricture, or its site in the canal, if there are no signs of disease of the stomach, gastrotomy may prolong life, if only for a short time, or at least enable the patient to pass with greater comfort the last few days of his existence; and there is the chance of cure being established by the formation of a permanent fistulous opening, although up to the present time the results of this operation have been nearly all unsuccessful. There is one point of importance to be attended to in these cases, that is, the necessity of ascertaining with certainty that the stomach is unaffected by the action of the escharotic, before resorting to the operation. It is manifest that, in a very large number of cases in which these poisons are swallowed, a portion, sometimes a considerable amount, finds its way into the stomach, producing destruction of the mucous membrane, inflammation, subsequent ulceration, and contraction, and occasionally stricture of the pyloric orifice.

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* *Guy's Hospital Reports* for 1859.

It becomes, then, a matter of great moment to discriminate between those cases in which the stomach has received a severe lesion and those in which it is unaffected, when the operation of gastrotomy is considered; for I should suppose no Surgeon would consider it justifiable to open the stomach when that organ had undergone any severe injury from the action of an escharotic. In Mr. Forster's case the stomach was healthy, and, beyond pain in the epigastric region, no symptom existed during life to lead to the opinion that that viscus was injured. But in the other cases already alluded to, where the stomach was found after death to be extensively diseased from the action of the poison, constant pain was complained of in the epigastric region, often of a severe character, violent retching, especially after taking food, besides other symptoms, which led to the opinion that that organ, as well as the œsophagus, was affected.

Gastrotomy. The operation of gastrotomy may be resorted to in those cases where a foreign body exists in the stomach which cannot pass off in the usual way, and the retention of which in this organ is likely to produce great danger to life; or in cases of impermeable stricture of the œsophagus, produced from swallowing the mineral acids, caustic alkalies, or any other cause. In both classes of cases, if any very severe gastric symptoms exist, the result of the operation, if performed, must be very doubtful. The following account of this operation is abridged from Mr. Cooper Forster's "Description of the Operation of Gastrotomy."*

The patient being placed upon his back in bed, the Surgeon standing on his right side, an incision, between three and four inches in length, should be made in the course of the left linea semilunaris, through the skin and fascia, commencing at the sternal end of the intercostal space between the eighth and ninth ribs, and extending

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* *Guy's Hospital Reports* for 1858, 1859.

downwards. The aponeurosis of the oblique muscles should be divided, when the outer margin of the rectus will be exposed; the transversalis muscle should then be cut through, and the transversalis fascia and peritonæum divided on a director to the same extent as the external wound. The stomach will then, most probably, be seen projecting below the margin of the left lobe of the liver; the anterior wall of the organ being carefully drawn forwards, an opening, about an inch in length, should be made into it, and the margins of this aperture sewed to the skin and parietes of the abdomen. A good portion (about a third of an inch) of the stomach should be included in the stitches, and the aperture con-
ected to the parietes by an uninterrupted suture. The opening in
he stomach being much less than the external wound, the remain-
ng part of the latter should be brought together by an uninter-
upted suture, leaving untouched the divided peritonæum. Chloro-
orm should not be administered, as all risk of vomiting should be
voided. After the operation, the patient may be fed from time
o time, through an elastic tube passed through the opening into
he stomach; the tube should be retained in the stomach for a week
r ten days after the operation, and not introduced at each time
utriment is given, as there is the risk of the adhesions between the
tomach and parietes giving way if it is not carefully introduced.

This operation has been performed seven times. Once by
hoval, in 1635;* twice by Sédillot;† once by Dr. E. Fenger‡ of
openhagen; twice by Mr. Cooper Forster;§ and once by Mr. S.
ones.|| These cases are appended in a tabular form, with the ex-
ption of one of M. Sédillot's, the particulars of which could not
e ascertained.

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* *Chelius's Surgery*, vol. ii. p. 391.
† *Traité de Médecine Opér.* tom. ii. p. 272.
‡ *Archiv für Path. Anat.* b. vi. p. 350.
§ *Guy's Hospital Reports* for 1858, 1859.
|| *Medical Times and Gazette*, Feb. 1860.

[Table

TABLE OF CASES

In which the Operation of Gastrotomy has been performed.

Date.	No.	Sex	Æt.	Operation, why resorted to.	Mode of Operation.	After-Treatment.	Result.	Cause of Death.	Operator.
1635	1	M.		For removal of knife, 6½ inches long, retained about six weeks.	By straight incision through left hypochondrium, two fingers' breadth, under false ribs. Wound joined by five sutures.	Tents impregnated with tepid balsam, and a cataplasm of bolar earth, white of egg, and alum applied.	Wound healed on the fourteenth day after the operation.		Shoval. *Chelius's Surgery*, vol. ii. p. 391.
1853	2	M.	58	Malignant disease of the œsophagus, opposite the larynx; great dysphagia. Symptoms 9 months.	A long incision on the left side, two fingers' breadth from the median line, and two centimetres below false ribs; a second incision, perpendicular to this, so as to make a cruciform incision. Stomach seized and fixed to abdominal wall by five or six points of suture carried through its peritoneal and muscular coats only; opening the stomach being postponed until it became united to the parietes. Chloroform given.	Two hours and a quarter after the operation, the stomach was partially torn from its connexions by a fit of coughing, and passed into the abdomen; drawn out again, and fixed to the skin by Assalini's forceps. The part thus included became gangrenous, and when removed five days after the operation, the stomach was opened into. The surrounding adhesions were then firm. Through this fistulous opening, wine, beef-tea, milk, &c. were introduced, but they would not remain in the stomach.	Death ten days after operation.	Exhaustion. Peritonitis.	Sédillot. *Gazette des Hôpitaux*, p. 164, 1853.
1854	3	M.	55	For obstruction of œsophagus from malignant tumour.	By transverse incision through left rectus muscle, along the cartilages of the ribs. Stomach drawn out, opened, and margin of the opening fastened to the parietes.	Consisted in preserving the stomach from the air by means of a bandage, with lint and gutta percha over the wound, and giving nourishing fluids, introduced through glass filter.	Death fifty-eight hours after operation.	Exhaustion. No effusion into peritonæum; no peritonitis.	Dr. E. Fenger. *Archiv f. Path. Anat. und Physiol.* b. vi. p. 350, 1854.
1858	4	M.	47	For epithelial cancer of œsophagus, complete obstruction of the canal, and consequent starvation.	As described in text. The orifice in the stomach, which was left, about large enough to admit end of little finger. Chloroform not given.	Milk, eggs, and rum, in small quantities, administered every half-hour, through an elastic tube passed into the stomach through the wound.	Death forty-four hours after operation.	Exhaustion. Peritonæum healthy; no inflammation or effusion of lymph or serum.	Mr. C. Foster. *Guy's Hospital Reports*, vol. iv. 1858.

TABLE OF CASES—*continued.*

Date.	No.	Sex	Æt.	Operation, why resorted to.	Mode of Operation.	After-Treatment.	Result.	Cause of Death.	Operator.
1859	5	M.	4 yr. 4 m.	For stricture of œsophagus from swallowing a solution of caustic alkali.	As described in text. Twenty-three weeks after swallowing the poison. Chloroform given; no sickness produced.	Milk and egg, and egg and wine, given alternately every hour, through a tube passed into the stomach through the wound, with nutritive injections of beef-tea.	Death on the morning of the fourth day after the operation.	Peritonitis, produced by the giving way of the adhesions between stomach and abdominal parietes. The immediate cause of the peritonitis being probably from the slight force employed in introducing the feeding-tube.	Mr. C. Foster. *Guy's Hospital Reports*, vol. v. 1859.
1860	6	F.	44	For epithelial cancer, involving pharynx and larynx, complete obstruction of the œsophagus, and consequent starvation.	As described in text. Difficulty in securing the cardiac end of the stomach, as it was drawn downwards, and more to the left than usual, by omental adhesion. Four ounces of blood lost during operation.	Tube, with funnel fitted at the upper end, placed in the stomach through the wound, and retained there until the patient's death. No irritation produced by it. Milk and brandy in small quantities, with small doses of laudanum: nutritive enemata.	Death thirty-six hours after the operation.	Exhaustion. No peritonitis.	Mr. S. Jones. *Pathol. Trans.* Jan. 17, 1861.

HENRY GRAY.

INJURIES OF THE CHEST.

FROM time immemorial these injuries have been described under two distinct heads, viz. those affecting the parietes, and those involving the contents, the pleura constituting the limit. Although the distinction is far too artificial, still, for practical purposes, we may adopt it on the present occasion. But before proceeding with our inquiries, let us invite the serious attention of the Surgeon to the very great importance of an accurate knowledge of the anatomy of the parietes of the chest, and the organs contained therein; for no one can possibly undertake to make any satisfactory diagnosis or prognosis, unless he be well acquainted with the fabric of the walls, and with the relative position and adaptation of the contents, as also with the varied phenomena of inspiration and expiration,—not forgetting the actual position of the diaphragm and its extensive encroachment within the domains of the chest, carrying along with it, as it does, many of the important abdominal viscera, such as the liver, stomach, &c., which lie under its expanded and protective walls. Moreover, the Surgeon should be thoroughly able to appreciate and detect all normal sounds of the lungs emitted through the parietes, by the aid of percussion and auscultation, as well as the natural sounds of the heart and its valves: for without this knowledge he could not possibly undertake to interpret the abnormal signs and sounds consequent upon disease and injury, such as the crepitation of fracture and that of pneumonia—the dulness on percussion, and absence of respiratory murmur in effusions into the pleura and pericardium,—the rubbing sounds of pleurisy and pericarditis, &c.

The arrangement of our subject will be as follows: firstly, wounds and injuries of the surface and parietes of the chest, usually denominated non-penetrating wounds; and this section will include fracture of the ribs, and contusion: secondly, wounds and injuries of the interior and the contents, called penetrating wounds, and to this section will be added the rare complication of injured viscera from contusion, unaccompanied by external breach of surface.

I. Injuries and Wounds of the Parietes.

In considering these lesions, we must bear in mind that the wall of the chest is built up of twelve pairs of more or less movable, semicircular hoops of bone, the ribs, which are attached to the spine behind by strong inextensible ligaments, and in front connected by means of elastic solid substances, the costal cartilages, to a central shield of spongy bone, the sternum;—that these cartilages often become ossified, in advanced age;—that between the ribs there are spaces filled up by muscles; and that there is an artery, vein, and nerve, running close along and under cover of the lower border of each rib, in the upper part of each intercostal space;—that the chest is further protected on its surface by the large and powerful muscles, which attach the upper extremity to the trunk;—and lastly, that, from its exposed position, additional security is obtained by the scapulæ and vertebral column behind, by the protective position of the arms depending on either side, by the clavicle, and by the almost instinctive movements of the upper extremity in warding off injury in front.

Contusions of the surface of the chest may be of a simple, uncomplicated character, partaking of the ordinary forms of contusion, which have been already described in the preceding volume; but they may also be attended with lesions to structures peculiar to this region, and will require special notice. Thus, contusions may be complicated with rupture of the superficial and thoracic vessels, which are of considerable size, and pour out blood freely. This effusion of blood may be confined merely to a certain space; but at other times it may be so very extensive, and so rapid, as to excite alarm lest the main trunk has given way. When seen several days after the injury, it is liable to be mistaken for acute suppuration; but the diagnosis will be based upon the sudden and rapid appearance of the swelling after the receipt of the blow,—the soft and fluctuating condition of the enlargement,—the absence of discoloration of the skin in the first instance,—and the absence of any inflammatory action afterwards. Sometimes the effusion may continue so as to cause tension by over-accumulation, but, generally speaking, these cases are by no means serious, provided they be not meddled with; and there are many instances recorded where he whole of the front of the chest on one side has been bathed in an extensive effusion of blood, and which have yet done well, without causing any bad results. The treatment, therefore, will consist in endeavouring, firstly, to arrest any further effusion of blood, thus favouring coagulation, by cold applications and the use of evaporating and saturnine lotions; and, secondly, to promote the absorption of the extravasated blood, when nature's efforts are sluggish and tedious, by the application of stimulating embrocations, care being taken not to carry this to so great an extent as to excite inflammation.

Sometimes contusions are complicated with rupture of some fibres of the powerful muscles, such as the pectoral; these accidents, however, are not very frequently met with in civil practice, but are by no means uncommon in military experience from the effects of spent balls, &c. Rupture of a muscle has been likewise observed in cases where the individual has fallen across a projecting body, or whilst falling from a height has grasped a fixed body during his descent. The accident is at once recognised by the total or partial loss of the use of the muscle thus injured, and by the sensible gap existing between the torn fibres. The treatment consists in the relaxation of the muscle and careful approximation of the ruptured ends by position; and this is to be maintained, if necessary, by means of bandages.

Contusions, complicated with *fracture of the ribs*, are injuries of very frequent, almost daily, occurrence, and this must be the case when they form one-ninth or one-tenth part of all fractures: thus, of 2275 fractures admitted into Guy's Hospital during a given period, there were 222 fractures of the ribs, exclusive of a large number of other cases of such injury, treated as out-patients; and of 2358 fractures admitted into the Hôtel Dieu at Paris, there were 263 fractures of the ribs. Both sexes are liable, but not equally so, for females are less exposed to injury and accident; thus, of 161 observations at Guy's, 25 were females, being a little more than a sixth; and of 263 observations at Hôtel Dieu, 48 only were females, being nearly a fifth. With regard to the age, the accident is found rarely to occur in the young, in consequence of the great elasticity of the structures; it is more frequently met with in elderly people, when the ribs have become more firm and the costal cartilages more dense, rendering them less capable of resisting shock, in consequence of some loss of elasticity. Of 161 cases admitted into Guy's Hospital, 9 were under 15 years of age, the youngest being but 2 years old; 26 between the ages of 15 and 30, 78 between 30 and 50 years, and 48 above 50 years old, of whom upwards of 4 were over 70:—thus, under 30 years of age there were 35 cases, and over 30 and upwards no less than 126 cases.

The causes must for the most part be referred to external injury, such as blows, falls, the passage of wheels over the chest, pressure between two opposing forces, &c. &c.; but in some very rare instances the ribs have been proved to be fractured from internal causes, viz. during the severe efforts of coughing. In these latter instances, the ribs have generally been found in some morbid condition; and Malgaigne has collected 8 such cases, 4 of which occurred in males and 4 in females; their ages were noticed in 6 cases,—5 from the age of 47 to 63, and 1 in a young man,—the ribs had given way at the anterior part, near the cartilages. M. Malgaigne remarks, that probably the ribs had undergone atrophic thinning, and that the fractures were the result of muscular efforts.

Respecting the condition of the fracture, the ribs may be broken in one of two ways: either at the seat of injury, by a forcible blow or fall on some projecting body, constituting what are termed direct fractures, and in such cases one or two ribs only are found involved, with the broken ends often driven inwards; or, secondly, the fracture may take place at some distance from the site of the external violence, hence called indirect fractures; here the ribs generally give way about their middle, or most convex part, at the point intermediate between the two opposing forces, as for instance in those cases where the chest is squeezed against a wall or a post, or where the wheel of a cart or vehicle passes over the chest:—in such fractures, three or more ribs are involved, and the fractured ends are often driven outwards.

Again, the fracture may be incomplete; that is to say, the ribs are only fissured, or, the periosteum being probably preserved and remaining untorn, no displacement or evidence of the existence of fracture is found. Complete fracture is where the rib has been broken through, either in a vertical or oblique direction, and the two ends readily grate against each other during forced respiration. In general there is no shortening, as met with in fractures in other parts of the body, and this is readily explained by the fact of the ribs being firmly fixed both in front and behind; and again, there is little or no vertical displacement, because the intercostal muscles are so placed above and below the injury as to prevent any separation in this direction.

Fractures are generally confined to one side of the chest, but in severe and complicated accidents both sides may be involved; in such cases the injury must always be regarded as of the most serious nature. Sometimes a rib may be broken in two places, or may even be comminuted; these cases are, however, rare.

The middle ribs are the most frequently injured, and least of all the first, second, and third;—thus, of 61 cases recorded at Guy's Hospital during a specified time, there were 44 cases involving the fourth, fifth, sixth, seventh, and eighth ribs; 13 cases with fracture of the last four ribs, and 4 cases in which the first three ribs were injured; the fracture of a single rib was observed in 9 of the cases.

Fracture of the ribs may be uncomplicated or complicated. By the former is meant such fracture as occurs without any external or internal lesion; a mere broken bone without injury to adjacent soft structures. Complicated fractures comprise, firstly, those co-existing with an external wound, analogous to compound fracture of the limbs; secondly, those where the rib or ribs have been broken into small pieces, as observed in gun-shot wounds, and called comminuted; thirdly, where the broken rib has pierced the pleura, causing pleurisy, &c.; fourthly, where it has penetrated the tissue of the lung, inducing emphysema, hæmorrhage, pneumonia, &c.; fifthly, where it has injured the pericardium and heart; sixthly, where it has wounded the intercostal vessels; and seventhly, where it has involved the diaphragm and abdominal viscera. All these complications will be referred to under the title of the special injury, such as wounds of the lung, emphysema, &c. &c. The relative proportion of uncomplicated and complicated fractures may be well exemplified by the analysis of 136 cases admitted into Guy's Hospital during the past five years: 108 were uncomplicated fractures, of which 8 only had secondary inflammation, which proved fatal in 2 instances from previous old-standing disease; 28 were complicated, 16 with emphysema, of whom 4 had symptoms of pneumonia, but all recovered, and of the remaining 12, 6 died at once from fatal collapse, and 6 recovered; of these latter 3 had hæmoptysis and emphysema, and 3 extensive injury and severe inflammatory symptoms.*

The ordinary symptoms and diagnosis of a fractured rib *per se* will consist of, firstly, the sensation expressed by the patient of his having felt something snap or give way: secondly, his complaining of pain at the seat of injury, a kind of severe stitch in the side, or catching of the breath during an irregular respiration, while he carefully avoids to take a deep inspiration or a prolonged expiration; even the slightest attempt to cough distresses the patient and disturbs the fracture, giving rise to the sensation of grating: thirdly, the partial arrest of the movements of the ribs on the affected side, as well as of those on the sound side, in consequence of their consonance of action; hence the respiration is carried on principally by the diaphragm and abdominal muscles: fourthly, the detection of crepitus, owing to the movements of the fractured ends one against the other; and this is to be ascertained by manipulative measures, either by simply placing one hand firmly over the seat of mischief, whilst the other hand is employed in making counter-pressure on the opposite side of the chest, and then instructing the patient to take a full inspiration; or by applying the hands one on either side of the supposed seat of fracture and making alternate pressure, so as to cause the two ends to rub against each other; or in very thin subjects, by taking hold of the rib in front and making the necessary movements; or lastly, should all these means fail, by having recourse to auscultation, which will often assist in detecting the crepitation of fracture, notwithstanding the depreciation of its value in obscure cases by some Surgeons of excellent authority. It must be borne in mind, that, although crepitus is an essential indication of fracture, yet in some rare instances it may escape detection, and more especially when one bone only is broken, and at a part where it is thickly covered by muscles or much fat, or where the periosteum has remained untorn: hence caution must be used in denying the existence of fracture in consequence of the absence of crepitus.

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* *Guy's Hospital Reports*, vol. vi. 1860.

The prognosis is in general exceedingly favourable, but of course it will be modified according to the primary and secondary complications, more especially the lesion of important structures. In old and elderly persons, who happen at the time to be the subjects of bronchitis, asthma, or other form of chronic disease, a guarded prognosis must always be given, even should the fracture be uncomplicated; for these individuals often succumb, in the one instance, to shock from their low state of vitality, and in the other to a kind of asphyxia from inability to free the lungs of the accumulated mucous secretion.

The treatment comprises local and constitutional measures. The local consist in maintaining the ribs in as perfect a state of rest as possible, and this is to be accomplished by rendering them immovable, by any of the following plans: firstly, and by far the most preferable, the application of long strips of adhesive plaster, extending from the spine to the sternum of the affected side, and successively applied to some distance both above and below. These possess the advantage not only of not being easily displaced, but of affording a more effectual relief by confining and restraining that side of the chest without affecting or interfering with the free action of the opposite side in the acts of respiration. Some Surgeons prefer the use of a large sheet of strapping, instead of the long strips, but its application is not so uniform or so satisfactory. Secondly, the use of a flannel roller, about one hand's breadth and eight to ten yards long, which is made to encircle the chest by several turns and with a moderate degree of tightness. It is, however, liable to slip, and requires a re-application every second or third day. Some use a broad sheet of linen, which is passed around the chest and fixed either by pins or needle and thread, and there maintained in this position by a kind of braces carried over the shoulders, similar to the double T bandage of the French; others again prefer a simple belt and scapulary, which is merely a mechanical adaptation of this latter. Thirdly, the use of compresses, pieces of pasteboard, splints, &c., which are sometimes required, more especially in those cases where the fractured ends are driven inwards; and the object of the Surgeon being to lever out the displaced bones, or at all events to prevent the ends from making further pressure on the internal structures, these splints or compresses are placed vertically on either side of the fracture at some little distance, and maintained there by strapping, when the whole is enclosed by encircling the chest by several turns of a broad flannel or linen roller. Fourthly, the recumbent position in bed has been recommended, and even adopted by some Surgeons, instead of local treatment, and without any application whatever: but this plan is rarely adopted, except in those cases where the least pressure or confinement of the chest gives pain and uneasiness. It is the exception rather than the rule, for in the majority of cases the confinement of the movements of the ribs is described as being grateful, giving great relief, and allowing a gentle, easy, and comfortable respiration.

The constitutional treatment will comprise the administration of the ordinary remedies, according to the general principles of surgery; such as rest and quietude for several days; a careful and judicious diet, abstinence from stimulating drinks; where much cough and bronchial irritation supervene, expectorants, diaphoretics, and demulcents, may be usefully employed. Where there is much dyspnœa, &c., the exhibition of antimony and antiphlogistics is highly important; the antimonial wine being the most effective medicine to be administered in frequent doses, and varied in quantity, according to the age and powers of the patient. Where there is hæmoptysis or subsequent pleurisy or pneumonia, in addition to these remedies venesection must be had recourse to; but this powerful agent must be judiciously and cautiously wielded. In properly-selected cases it acts as a charm, and often snatches the sufferer from impending death: its chief indications are, the continued and distressing dyspnœa, the oppressed circulation, as evidenced by the labouring pulse, and the strength and powers of the individual. In former years it was too much the fashion to employ the lancet in cases of fractured ribs; but latterly the current of practice has rather flowed towards the opposite extreme, perhaps too much so; however, the Surgeon must be entirely guided by circumstances, and meet the difficulties and complications as they arise, by adopting prompt measures, recollecting that the young bear active treatment better than old people. Of the 136 cases already alluded to, as admitted into Guy's Hospital, the majority of the cases, viz. 100, required little or no constitutional treatment, and of the remainder only three required venesection. In appropriate cases of internal inflammation, mercury is invaluable.

Fractures of the sterno-costal cartilages, uncomplicated with other injuries, are exceedingly rare, although recorded as early as the year 1698, by Zwinger, who found this injury when examining a dead body, and in 1805 by Lobstein. Majendie has written a thesis on the subject, wherein he states, that he had seen upwards of five examples in the space of two years. Malgaigne, in his recent work on fractures, writes, that he had only seen three cases; and that at the Hôtel Dieu, there was only one case in 2328 cases of fracture generally. He attributes this paucity to the probable omission of this lesion in the hospital returns. The causes of this injury may be, like those of the ribs, direct or indirect. The eighth rib is said to be the one most liable, then those immediately above it: generally speaking, one end overlaps the other, which renders the diagnosis easy, and these ends may become united in that displaced condition by osseous matter without any subsequent ill effects. The treatment will be the same as for fractured ribs: some, however, have recommended that, where one end overlaps the other, pressure should be made, so as to restore them to position; but inasmuch as great force must necessarily be used, which may cause injury to the soft parts, and the risk of inducing sloughing of the integuments, this plan is generally deprecated. Malgaigne states that he has used with success a modification of the common truss, furnished with well-protected pads: the one pad is placed on one side of the fracture, the semicircular spring made to encircle the chest, and the counter-pad made to press upon the other end of the fracture. By this means in one case, after twenty days' application, he found the fractured ends *in situ*, and a perfect cure resulted.

Fracture of the sternum is also by no means common, for during eleven years at the Hôtel Dieu only one example is recorded; and at the Middlesex Hospital, according to Mr. Lonsdale, two cases were met with in 1901 fractures. At Guy's Hospital, during the past five years, two cases have occurred, the last one only just recently; it was not detected during life, but was associated with other more severe injuries; one case was admitted in 1843, another in 1845, and another in 1846. It is probable, however, that the rarity of this injury has been exaggerated. Fracture of the sternum alone is, indeed, an extremely uncommon accident; but as a complication of fractures of the spine or ribs, it is much more frequently met with: thus, at St. George's Hospital, during the four years 1857-1860 inclusive, nine cases of fractured sternum were dissected; of these, three were associated with fractured spine, and six with fractured ribs.

These fractures may be either transverse or longitudinal; the transverse are the most common, but are by no means always transverse, in the strict sense of the term; the causes are generally direct external injuries. The fracture is often associated with other severe lesions, such as fractured spine, ribs, skull, &c.; or it may be produced by indirect violence, by the forcible bending of the body backwards in falling across a projecting body, thus snapping the bone or tearing asunder the first and second pieces of the sternum; such cases are quoted by Sabatier, Rolando, and Malgaigne. Sometimes the contrary condition will cause it, viz. the forcible flexure of the trunk forwards, and the simultaneous occurrence of a contre-coup, by falling either on the feet or the head. Sometimes, but rarely, it has followed excessive muscular action: Chaussier relates two examples of the kind; they were both females, of the ages of 24 and 25, and the fracture occurred during the efforts of labour with a first child; at the time of parturition both patients threw back their heads, and rested at times on their arms and heels, bowing up their bodies; there was only slight displacement of the fracture in the one case, and none in the other. This accident has happened to a celebrated vaulter, who, whilst bending his body backwards, was endeavouring to raise a heavy weight with his teeth.

The symptoms are the following: the sensation of a breaking or cracking at the time of the accident; pain at the seat of injury, aggravated by deep inspiration or coughing; the detection of the fracture by manipulation, or else by the overlapping of the bones, if displaced. Sometimes there is no displacement, owing to the fibrous and fascial investment remaining intact; but generally the bones ride over each other, and, in nearly all the recorded cases, it is the inferior fragment which lies in front, and is the most fixed portion; notwithstanding its movement during respiration, being pushed forwards in inspiration, and backwards in expiration, the displacement causes no inconvenience.

The diagnosis is generally easy, except where there is much swelling and effusion.

The prognosis is favourable, where there is no complication nor other severe injury.

The treatment will be the same as for fractured ribs; sometimes the bandage or strapping cannot be borne, so that the patient must be kept in the recumbent position: sometimes, though rarely, he cannot even bear this, and is only comfortable when in the sitting position, with an inclination of the body forwards, resting the head in front; and in this state some have actually remained for eight days. Where the bones have been much displaced, efforts have been made by some Surgeons to reduce the fracture, by placing a cushion under the chest, and throwing the shoulders well back, and pressing, at the same time, on the ribs below, thus causing an increase of the arch, and so bringing the edges of the bones into apposition: many other plans have been devised for the same object, but in general, although the reduction may be perhaps readily effected, the difficulty consists in retaining the ends *in situ*. Respecting the suggestions for the use of a kind of corkscrew, to be screwed into the depressed portion, so as to draw it up, and for the employment of elevators and trepans, all these must be considered as not only useless, but the relics of the old cruel and barbarous surgery.

Longitudinal fractures of the sternum are very rare, so that their occurrence has been denied by many authors. Two cases are mentioned by Ploucquet, and one by Barran. The latter case is quoted by Malgaigne, as follows: a mason, aged 60, fell from a scaffold on some large stones; the fracture was longitudinal, and the right portion depressed about eight to ten lines; the left somewhat overlapping: reduction was effected by drawing the arm to the side, and carrying it backwards, then pressing firmly on the middle of the right sternal ribs, making alternate movements from before backwards, so as to disengage the bones, whilst, at the same time, gentle pressure was made on the left or riding portion, so as to keep it on its own level. After reduction, a compress was applied, and maintained by a firm bandage: the case was successful at the end of six weeks, and no deformity resulted.

Fracture of the sternum may be complicated with other injuries, as has already been partially alluded to. The most ordinary complication of this fracture is its occurrence in cases of fractured spine; but sometimes it may cause injury and inflammation of the pericardium, pleura, lungs, mediastinum, heart, &c. These complications will be alluded to in considering the injuries of those structures.

Contusions of the parietes are sometimes followed by inflammation, suppuration, and the development of tumours; these subjects have been treated of elsewhere. In the female the mamma is peculiarly liable to injury; a subject which will be referred to under the head of Diseases of the Breast. There is one complication, however, which requires special allusion in this place; it is that of subpectoral abscess, or diffused suppuration under the pectoral muscles, which is generally the consequence of injury. It is attended with severe constitutional symptoms, but the local signs are very obscure, and give no definite indication of its existence; there is great pain, and general tumefaction in the pectoral region, and no evidence of fluctuation, unless the pus reaches the axilla, when its presence may be detected. Its diagnosis must mainly be based upon the constitutional symptoms, viz. severe constitutional irritation, with febrile disturbance and unmistakable rigors; these, with marked tumefaction, fully warrant the Surgeon in making an exploratory incision through the pectoral muscles, in the direction of their fibres, so as to give an exit to the pus. In the course of the last ten years the author has had occasion to perform this operation on four several occasions, and with satisfactory results. After the matter is evacuated, it is essential to keep the wound open, by the introduction of a tent, or else the muscular fibres will close the opening and a re-accumulation ensue. The tent is to be replaced once or twice daily, as occasion may require. Tonics and good diet must be administered.

Wounds of the parietes of the chest, commonly called non-penetrating wounds, include the several varieties of incised, punctured, lacerated, and gun-shot wounds; the general characters of which are described in the essays on WOUNDS and GUN-SHOT WOUNDS. Here we shall merely refer to certain special complications of the ordinary incised, punctured, and lacerated wounds, as they affect the surface and tissues of the chest. In the first place, the Surgeon is always anxious to decide whether the wound be superficial or penetrating:—are there any signs sufficiently well-marked to indicate that the wound has not penetrated the chest? This question will be more appropriately considered when alluding to penetrating wounds, for it will be found that the only reliable signs are those of a negative character, viz. the absence of all the symptoms indicating a penetrating wound.

Wounds involving the skin and cellular tissue of the chest require no comment, otherwise than in the punctured variety; where there may be a long track traversed by the weapon, which may give rise to the formation of sinuses and local abscesses, and be difficult to manage in consequence of the movements of the upper extremity and the acts of respiration.

M. Vidal* remarks that punctured wounds, even of the slightest character, may be attended with symptoms simulating those of lesion of some internal organ or internal hæmorrhage; such as coldness of the skin, feeble circulation, a sense of suffocation, syncope, and cough. These phenomena, he states, are chiefly observed in wounds received in duels. Whatever may be the courage of the champion, at the moment of combat the blood does not circulate normally, and the innervation is not regular, and he is not without emotion; if to this moral state there is superadded a wound of the chest, the wounded person regards it with most vivid uneasiness, and if fear has not already set in, it will soon take place. Thus is readily explained the occurrence of the above phenomena, and the salutary effect of removing these impressions by moral and assuring means.

Wounds of the muscles in front and behind the chest, when passing across their fibres, are attended with very great separation, and leave a large gap, in consequence of the power and extent of the individual muscle involved. And in the treatment of such wounds, the function of the divided muscle must be borne in mind, so that the edges may be approximated as closely as possible; thus, in wounds of the muscles in front of the chest, the arm must be drawn forwards, and carried inwards towards the opposite, and maintained in this position during the healing of the wound: in wounds of the muscles behind, the opposite course is to be pursued. In a case of extensive wound of the latissimus dorsi muscle, and in a case of wound of the pectoralis major, M. Petit applied several points of suture, and with success: but sutures through muscular tissue are in general not advisable, unless there be a very large flap; and when employed, they should include the fascia in front of and behind the muscle, else the suture will tear away. Transverse wounds of the intercostal muscles weaken the chest, and sometimes permit the escape of the lung, to which we shall refer further on.

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* Vidal de Cassis, *Traité de Pathologie externe*, tom. iv. p. 66.

Wounds of the thoracic and other parietal vessels (excluding the intercostal and internal mammary) partake of the ordinary characters of wounded vessels: the only peculiarity in respect to the chest is in reference to punctured wounds, as in stabs by a sword, bayonet, foil, &c., where a vessel has been involved, and the blood, not being able to escape externally, has diffused itself under the muscles in the loose cellular tissue, and sometimes to a very great extent. This extravasation may coagulate, and further effusion cease, when subsequent absorption ensues, with speedy recovery: on the other hand, it may excite inflammation, suppuration, and sloughing. Ice, or carefully applied compression, will be sufficient to arrest the hæmorrhage, if not of very considerable extent; but where one of the larger trunks, such as the vessels of the axilla, has been injured, the case must be treated according to the rules laid down in the essay on WOUNDS OF ARTERIES.

Wounds involving the ribs, costal cartilages, or sternum, require immediate closure of the wound, and the ordinary treatment for fractured ribs. Here, however, we must be on our guard, and ascertain whether or not a portion of the weapon or instrument has been broken off and become imbedded in the rib, or cartilage; an event which has happened once or twice. In general the piece is loose, and readily removed, but in some instances it has been found fixed, requiring immense force to extract it; or it may be smooth and convex on its surface, such as a bullet, when difficulty is experienced in laying hold of it. Sometimes the pointed instrument may traverse the rib and appear on its inner side, causing a penetrating wound of the chest; this we shall refer to again.

Non-penetrating wounds may be attended with emphysema; thus, in wounds traversing the soft parts obliquely and gliding under the large muscles of the chest into the subjacent loose cellular tissue, the air from without may enter into the wound, being drawn in by the movements of the ribs; and this air, not being able again to escape, during expiration becomes diffused, causing emphysema, which may occupy a very extensive surface. A great deal of this air may be pressed out through the wound, but in so doing, care must be taken to close the wound at each inspiration, so as to prevent fresh air being drawn in.

II. Injuries and Wounds of the Contents of the Chest.

These will be treated of under two separate heads: first, those produced by external wounds, commonly called penetrating; and second, those caused by contusion, without any breach of the external surface.

Respecting penetrating wounds, these will be best considered by studying them according to the organ or structure involved, in the following order. 1. Wounds of the pleura and lungs, with their attendant complications; 2. Wounds of the mediastina, pericardium, and heart; 3. Wounds of the intercostal, internal mammary, and large vessels of the chest; 4. Wounds of the œsophagus.

1. *Wounds of the pleura and lung, and their complications.* In the first place, there may be a simple penetrating wound of the pleura, without injury to any other structure. This accident is exceedingly rare, and to the anatomist might appear scarcely possible, in consequence of the close adaptation of the lung and its pleural covering to the wall of the chest and its pleura; there are, however, sufficient facts proving that this injury does now and then take place, more especially in incised wounds; although its recognition is very difficult. Where the wound is large and the lung distinctly visible, and air is freely drawn in and expelled from the pleural cavity during respiration, the evidence is palpable enough; but these wounds in general are not so extensive, owing to the protection of the ribs, hence we must rely upon other diagnostic marks. And here we are again baffled, because the chief signs are entirely of a negative character, viz. the absence of all the varied indications of a wound of the thoracic contents. The following means have been proposed to assist in the diagnosis: 1st. Deductions drawn from the weapon used, with its attending external circumstances; these will comprise the consideration of the varied forms of penetrating instruments, the extent of the blood-stain upon the blade, the size of the wound compared with the breadth of the blade, the respective positions of the injured person and the aggressor at the time of the infliction of the wound, the mode and

direction in which the weapon was thrust, &c. These points are by no means decisive, and are often doubtful; for the blade may have two cutting edges, and then the wound will be larger; the bayonet or sword-thrust may glance off the ribs and pass a long distance under the skin, without entering the chest,—thus cases are related in which a sword has passed from the right to the left of the chest, without penetrating the cavity; again, the position of the combatants is often inaccurately stated. 2d. Exploration by means of the finger, probe, sound, or other instruments. Were this to be permitted, and a careful and minute examination made by the introduction of the finger into the wound, an easy diagnosis would at once be realised; but in wounds of the chest, as in wounds of the abdomen, all manipulative examination is to be denounced as perfectly unwarrantable, being attended with highly dangerous results, by disturbing nature's efforts to effect a repair, disarranging the clot, and exciting irritation and inflammation; a proceeding tending only to gratify curiosity, without the slightest benefit to the patient. The same remarks apply to the injecting of fluids into the wound, which is to be considered as a relic of barber-surgery, and is wisely expunged from all modern works. 3d. Another mischievous and meddlesome proposition is the following, viz. the closing of the external wound, and then directing the patient to take a deep inspiration, when he is to hold his breath so as to close his glottis; and then to make an effort to expire, at the same time that the Surgeon re-opens the wound and holds a lighted candle close to it: should the wound have penetrated the lung, air will be driven out through the opening and blow the flame of the candle to one side. This must always be regarded as a dangerous and hazardous experiment; and even if justifiable, it is not conclusive evidence, for in many cases of penetrating wounds of the lungs, there are several circumstances which may prevent the escape of air from the organ. 4th. The absence of emphysema is no indication that the lung has not been wounded; emphysema, although a usual symptom of injured lung, may occur even in non-penetrating wounds, as has been already mentioned; it may also take place in wounds penetrating the pleura cavity only: thus air may be drawn in through the external wound during inspiration, and on expiration this air, not finding a ready exit, may be expelled into the neighbouring cellular tissue: or i the incised wound be very large, the air will enter the cavity in a large volume, and should it be unable to escape, it will cause a pneumo-thorax. 5th. The absence of hæmoptysis is by no means a sufficient test that the pleural cavity only has been penetrated

Hæmoptysis, although usually a symptom of injured lung, may take place in non-penetrating wounds, and even in injured lung it may be absent; hence the Surgeon must be very cautious in relying upon individual symptoms.

Thus, then, there are no absolute signs upon which we can decide; we must await the issue, and maintain a strict watch for any symptom or complication which may set in; our prognosis must be guarded, and must always be considered unfavourable for at least four or five days, before the patient can be pronounced to be out of danger; and in expressing any opinion, it must be recollected that the Surgeon is not bound to state whether a wound has penetrated the chest or not.

The primary complications which may ensue in this class of njuries are, emphysema, pneumo-thorax, hernia of the lung, and the presence of foreign bodies in the wound or cavity. The secondary, or subsequent, complications are, pleurisy, hydro-thorax, empyema, fistulous openings, contraction of the side of the chest, &c. These will be alluded to in their appropriate place.

The treatment will differ but little from that laid down in non-penetrating wounds, viz. the removal of foreign bodies, the arrest of hæmorrhage, the immediate closure of the external wound, and strictly enforcing the recumbent position until the period of danger has passed over. The patient must be kept on low diet, and arefully watched in the interim, and the slightest indication of ny untoward symptom is to be treated with energy, according to he instructions given further on.

A curious complication of a penetrating wound without lesion of viscus is the escape of an uninjured lung through the aperture, constituting a hernia of the lung, or *pneumocele.* There are two varieties, both of which are comparatively rare; the one occurring t the time of the infliction of the wound, and called immediate, the her taking place after cicatrisation of the external wound, and alled consecutive.

The immediate variety is seldom observed, for in general the scape of the lung is difficult, owing to the tendency of the external r to find its way in through the wound during respiration, and hus prevent any protrusion by pressing the lung away from the ound; the hernia, therefore, must take place before the air has me to enter the chest; and the following explanation of its production has been offered. If there be a large wound, and the chest e at the time suddenly contracted with direct closure of the glottis, the air in the lung, not being able to escape by the trachea, becomes pent up in the air-cells, distending and forcing the organ against the parietes, and causing its escape where the latter are deficient. The most frequent situation in which wounds are liable to be followed by hernia of the lung, appears to be at the anterior part of the chest, on a level with the nipple; and this is said to be due to the greater mobility of the lungs in this region, the rarity of any adhesions, and the nearer approach of the wound to the free edge of the lungs, which would more readily find exit. The size of the hernia varies from that of a small marble to that of a cricket-ball, and it forms a more or less globular mass, consisting of the lung-tissue, covered by its own pleura, and having no investing sac; its base is constricted, and encircled by a kind of neck, formed of the external wounded integument and the tissues in the intercostal space. The protruded lung may be at first simply congested; but this congestion may increase to such an extent that the lung may assume a very deep black colour, without, however, any loss of vitality; but when the constriction continues, and the congestion and exudation increase, together with long exposure, gangrene will ensue, and sloughing off of the whole mass take place, constituting a natural cure. The prognosis of these cases is generally favourable. The treatment will depend chiefly on the state of the lung, and the length of time which has elapsed since its prolapse:—if the prolapse be recent, and the lung healthy in appearance, it may be reduced by careful and moderate manipulation, care being taken not to injure its delicate structure in so doing; should, however, this be impracticable, owing to the very great constriction of the neck, the latter, provided it be formed entirely of soft structures, may be cautiously divided, care being taken to avoid wounding the lung or the intercostal vessels. If the lung be in a gangrenous condition, it may be left to nature to throw it off by sloughing; or it may be surrounded by a ligature, and tied; or it may be excised, in order to expedite matters:—all these measures have been severally and successfully tried. Thus, Rolando cut the prolapse off, and powdered the surface with astringents; and with success:—Tulpius tied the pedicle, and excised the remainder; the patient recovered in fifteen days, having had only a slight cough, and died six years after, when, on examination, the lung was found adhering to the pleura, at the seat of injury, but without notable alteration in its structure:—Fabricius relates a case, in which the hernia was cauterized with the hot iron, and a recovery effected, the patient living many years:—Ruysch details a case, in which a ligature was applied, and the mass allowed to slough off, and with favourable results. These instances are introduced here as showing how a delicate organ, like the lung, may resist such measures, and not as examples for pursuing the same line of treatment, which is too hazardous, risking the production of pneumonia, and other serious mischief. It is certainly more rational and harmless to leave the hernia alone, under all circumstances, where we are unable to reduce it.

An immediate hernia of the lung may occur without any external wound, as observed in rare cases of extensive comminuted fracture of the ribs; here the lung is generally injured, and the lesion itself is so severe as to be attended with almost immediately fatal results. It has also been described as having taken place during violent straining in the efforts of parturition.

The consecutive variety is when the protrusion takes place after the external wound has closed: thus Velpeau records the case of a man, aged 29, who received a sword-thrust at the inner side of, and a little below, the left nipple; he lost much blood, but had no hæmoptysis; the wound healed in six weeks, and in three months and a half after the injury he was admitted into the hospital with prolapse of the lung; the latter was found fixed in its present position, and was therefore left alone. In this class of cases the lung is covered by integument; the development and progress of the protrusion is very slow, and it may sometimes attain a considerable size. The signs of this occurrence will be, the appearance of a soft tumour, which is more or less circumscribed, elastic, and indolent; the integuments covering it are perfectly natural, and without any change of colour. The swelling moves simultaneously with respiration, expanding in expiration and diminishing in inspiration; it enlarges equally at all points during coughing; and if respiration be suspended for some time, the tumour disappears. On manipulation it crepitates and imparts an impulse on coughing, and the depression in the parietes can be readily felt. On auscultation, it emits numerous vesicular bruits; the respiratory murmur is normal, but is louder and less mellow than in the natural situations.

The treatment will consist in protecting this hernia from external injury, and in preventing the further protrusion of the viscus: this may be done by means of carefully adjusted pads and bandages: some have recommended the application of a hollow-padded truss, to be made on the same principle as that of the umbilical truss.

Congenital and spontaneous hernia of the lung are exceedingly rare; these varieties do not come under our consideration in this work.

A wound of the lung may be superficial or deep; and when arising from external wound, it may be either of the incised, punctured, lacerated, or gun-shot variety; but when produced by fractured ribs, it is generally of the lacerated kind. The incised wounds are the most dangerous, as they almost always give rise to immediate hæmorrhage and escape of air; the lacerated wounds are next in severity, on account of the retractility of the lung-tissue; punctured wounds, such as are caused by a stab, are the simplest form, and offer a more favourable prognosis;—gun-shot wounds have been specially considered in a previous essay (see p. 57).

Three conditions generally take place when the lung is wounded,—the escape of blood or hæmorrhage, the escape of air from division of the air-vesicles or tubes, and a more or less collapsed state of the organ. The escape of blood may take place into the parenchyma of the lung, causing ecchymosis, or a kind of pulmonary apoplexy, and this is generally met with in superficial wounds, and in the punctured variety; it may escape into the air-tube, and be coughed up with the sputa, constituting hæmoptysis; it may pass through the parietal wound externally; or it may flow freely into the cavity of the pleura, producing hæmo-thorax. The escape of air may likewise find its way into each of the above situations, viz. into the lung-tissue, causing lobular emphysema, as observed in punctured wounds; into the bronchi, mixing with the blood and sputa, and forming a mixture of a frothy red character; into the pleural cavity, inducing a pneumo-thorax; or it may escape externally through the parietal wound, but more generally it becomes diffused into the subcutaneous cellular tissue, producing more or less extensive emphysema. The collapse of the lung may or may not take place, and this will depend a good deal upon the antecedent circumstances: where a lung has become adherent from old pleuritic adhesions, no collapse will ensue, nor any escape of air or blood into the pleura; hence a favourable issue will be expected.

The repair of a wounded lung may take place in a few days; slight inflammation and exudation of plastic material ensues, causing a partial hepatisation, then organisation of the thin plastic effusion, when contraction and cicatrisation follow; all of which may be completed in from ten to fifteen days. In a few rare instances, immediate union has been proved to have taken place.

The symptoms diagnostic of a wounded lung, excluding the primary and secondary complications (viz. emphysema, pneumothorax, hæmo-thorax, pleurisy, pneumonia, &c.), are the following: 1st. The escape of blood and air through the external wound, of a pale red and frothy character; this symptom will be a strong presumptive evidence, but its absence by no means indicates that the lung is not wounded: there may be an influx and efflux of this frothy blood during inspiration and expiration, should the wound in the lung be opposed to the external one. 2d. The issue of blood mixed with air and mucus from the mouth during the efforts of coughing; and this is always to be regarded as a dangerous sign, for bleeding is generally abundant in severe wounds of the lung, and in such wounds, the complete expulsion of the blood being impossible, it accumulates in the tubes, producing a choking sensation, and may suffocate the patient. 3d. A deeply fixed pain in the chest, and a considerable degree of irritation and tickling in the larynx, inducing a constant desire to cough. 4th. Dyspnœa and difficulty in respiration, owing to partial collapse of the lung, or pressure upon its structure.

The constitutional symptoms are, in the first instance on receipt of the injury, those of collapse, arising either from shock or great loss of blood: this symptom need not excite alarm, unless it extend over a protracted period. After a short time reaction ensues, and to this condition the Surgeon directs his chief attention: inflammation and inflammatory fever, pleurisy and pneumonia, are next to be apprehended, and to be warded off if possible: the symptoms and treatment of these complications do not come within the province of this work.

The prognosis of wounded lung must generally be regarded as unfavourable, even when unattended by any dangerous complication.

The local treatment will consist in arresting any hæmorrhage from the superficial vessels, in removing all extraneous bodies, and in closing the external wound as quickly as possible, so as to prevent air being drawn into the chest; and then confining the chest to a state of repose by carefully-applied strips of adhesive plaster, extending from the spine to the sternum. The external application of ice to the chest has been used in severe hæmoptysis, and with the best effects. The constitutional measures will comprise the adoption of such remedies as are appropriate for the particular stage in which the patient is found: thus in the stage of collapse it is not desirable to interfere, for collapse is the means by which hæmorrhage is restrained, by allowing coagulation to take place in the divided vessels. The patient should be left in the position in which he is found, or be carefully carried to some more convenient locality; the room or place should be cool, and every measure tending to prevent hæmorrhage should be adopted. In the stage of reaction much energy, discretion, and sound judgment must be displayed by the Surgeon, and his attention must be mainly directed to the degree and severity of the hæmoptysis, dyspnœa, and thoracic complications: total abstinence from food and exciting drinks must be enjoined for the first few days; the internal exhibition of ice and cold diluents is acceptable; the judicious and prompt use of the lancet will cut short a severe hæmoptysis, and will tend to prevent the subsequent development of inflammation. Venesection should be performed in the semi-erect posture, and the blood taken *pleno rivo;* and we should bear in mind that the object of the venesection is not so much to take away blood as to make a sudden impression on the general system, so as to induce an artificial collapse. Dr. Macleod remarked that the cases of gun-shot wounds of the lungs, in the recent Crimean campaign, which did best, were those in which early active and repeated bleedings were had recourse to. The employment of the remedies prescribed in cases of hæmoptysis may be used with effect, such as sulphuric acid in large doses, acetate of lead, &c. In the stage of inflammation, the treatment will comprise the adoption of the measures detailed in works on the practice of medicine, under the headings pleurisy, pneumonia, &c. &c.

The following complications, although generally associated with wounds of the lung, may occur from other causes. We have had occasion to mention these complications incidentally, but shall now describe each separately.

a. Emphysema, or the infiltration of air into the subcutaneous cellular tissue, when occurring in the region of the chest, may be due to one of four conditions: the first, and by far the most frequent form arises from fracture of the ribs, where the broken bone has penetrated the pleura and entered the lung, allowing air to escape: the second, from penetrating wounds of the lungs or bronchi; where on inspiration the air received into the lung escapes from its wounded part into the chest, and on expiration is forced out through the external wound, diffusing itself in the cellular tissue; if the external opening be large and directly corresponding to that in the lung, no emphysema may take place, but in oblique and punctured wounds it is almost always present, and increases during every successive act of respiration: the third, from penetrating wounds of the pleura without any lesion of the lung, where the air enters from the exterior during each inspiration, and on being forced out again at expiration, cannot entirely escape, but diffuses itself under the integument: the fourth, and rarer, form proceeds from rupture of the air-cells without any external wound or fracture; this latter is generally found occurring in idiopathic emphysema, and arising from pathological causes, such as the bursting of a vomica; but it may be observed in traumatic cases, as from violent efforts while holding the breath in parturition, and in the rare instances of rupture of the lung from external violence without fracture or wound: and we may here include those cases in which the air makes its way into the posterior mediastinum, travelling up through the superior opening of the chest into the cellular tissue of the neck, and then diffusing itself through the body.

The symptoms of emphysema consist of a swelling of the integument, commencing at the seat of mischief, and gradually and progressively increasing in all directions, the skin remaining of a perfectly natural colour; this swelling has a peculiar and distinctive character, which renders its diagnosis easy, viz. a crepitating and crackling feel under pressure, by some compared to the feeling of a dry bladder half-filled with air,—it is elastic, but the air may be made to change its situation by digital pressure; it speedily returns, however, on removal of the finger, and is thus unlike œdema and anasarca, which pit on pressure, and remain so for some time: there is no attending pain. In some cases, where the wound of the lung has been very large, it may extend from head to foot in an incredibly short time; the patient being, as it were, blown out to an enormous size. The constitutional symptoms will depend upon the pressure exerted by this diffused air upon important organs, such as the trachea; its diffusion into the mediastinum and into the pleural cavity; when the patient will complain of tightness of breathing, followed by increased difficulty, which will become almost insupportable, so that he cannot lie down: impeded aeration of the blood and obstruction to the circulation soon show themselves, by the livid red, swollen, and suffused countenance, the weak, contracted, and afterwards irregular pulse, cold extremities, and, if this condition be not relieved, death by suffocation.

The prognosis is in general very favourable, except in cases of extensive wounds.

The local treatment will in some measure depend upon the nature of the cause: thus in emphysema from fractured ribs, a question arises whether or not a bandage or strapping should be applied. Abernethy* speaks in favour of this practice: "Pressure by bandage not only hinders the air from diffusing itself through the cellular substance, but serves to prevent it from escaping out of the wounded lung, and of course facilitates the healing of the wound, which would be prevented by the constant transmission of air. Its early application, therefore, will often prevent a very troublesome symptom, whilst at the same time, by keeping the fractured bones from motion, it greatly lessens the sufferings of the patient." Samuel Cooper,* on the other hand, remarks: "When emphysema is complicated with a fractured rib, the latter injury is unquestionably a reason in favour of a bandage. But whether the pressure of the roller will be useful or hurtful with respect to the emphysema itself, or the state of lungs and respiration, may be questionable. As for its tendency to resist the diffusion of air in the cellular tissue, this circumstance does not appear to me important, because the air thus diffused, much as it disfigures the patient, is nearly harmless, at least so long as the great serous cavities and the interlobular texture of the lungs remain uninflated; a danger, also, which no bandaging has any tendency to prevent. Neither will a bandage have so much effect in hindering the diffusion of air as scarifications, with this important additional consideration, that punctures, or small incisions made over the broken rib, prevent the spreading of the air, by letting it escape, while a bandage can only do so by more or less resisting its escape from the cavity of the pleura, which mode of operation in some cases would dangerously interfere with the continuation of respiration by the lung of the opposite side." It appears best to be guided in this respect by the patient's sensations. If moderately firm pressure on the injured part of the chest with the hands affords relief to the breathing, it will be right to make trial of the bandage; but if this appears to increase the pain or the dyspnœa, its use must be abandoned. Some Surgeons are great advocates for making punctures, or small incisions, in emphysema; but in general they are not requisite, and should form the exception rather than the rule, to be employed when the air has diffused itself over a great extent of surface, and not to be performed over the fractured bone if it can be avoided. Where emphysema is due to the external air being drawn in through a wound during respiration, the treatment will be to force out again as much air as possible, and to close the wound. Where it is due to penetrating wounds of the lung, is the external wound to be closed or left open? Both plans are liable to objection; thus, if the wound be closed, there is no direct vent for the air to escape, and the effusion continues to extend more rapidly; and, on the other hand, if the wound be left open, the external air may be drawn in and increase the mischief. Larrey* gives an excellent case in point: "The emphysema arose from a wound of the lungs by a lance. The whole body was prodigiously swelled; the integuments so distended that the limbs were inflexible, the eyes buried, and the lips so enlarged that nothing could be introduced into the mouth. The pulse and respiration were scarcely perceptible, and the voice feeble and interrupted. The lance had entered obliquely, under the lower angle of the scapula, and although the external and internal orifices of the wound were not parallel, the Surgeon had applied adhesive straps, and closed the external one. Hence the air, as it escaped from the lungs, distended the cellular tissue." Larrey immediately removed the dressings; and with a bistoury made the opening in the pleura and skin parallel. Cupping-glasses were then applied over the wound, and quickly filled with air and blood. The lips of the wound were now brought together, and kept so with a suitable bandage. Cupping-glasses and scarificators were applied to various parts of the body; and in others incisions were made with a scalpel. The patient recovered.

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* *Surgical Works*, vol. ii. p. 179.

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* *Surgical Dictionary*, 7th ed., p. 489.

The constitutional measures will be, to relieve any urgent dyspnœa, to diminish the violence of the respiratory efforts, and to lessen the heart's action, taking care not to depress the patient too much. Antimony and ipecacuanha are the most essential remedies, given in full and repeated doses. Venesection must be employed where there is much pulmonary congestion and oppression of the circulation.

b. Pneumo-thorax is when the air is confined to the cavity of the pleura, and is generally concomitant with emphysema, so that the two might be treated of together; however, to render the subject less complicated, they are described separately. The causes of this accident are the same as those of emphysema, and the same remarks apply to it. When it occurs in a moderate degree and in conjunction with emphysema, it does not attract the Surgeon's notice; but his attention is at once arrested when it begins to interfere with the lungs, and compresses them towards the spine and centre of the thorax. Pneumo-thorax may also arise from disease of the lung, especially in phthisis; hence its study is more appropriately referred to in works on medicine. In this place, reference will be made only to its symptoms and treatment in connexion with injuries and wounds of the chest. The symptoms are, urgent and distressing dyspnœa, tympanitic resonance of the chest on percussion, amphoric respiration, and a kind of metallic tinkling or a ringing metallic resonance on auscultation, if the lung is not too much compressed.

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* *Mém. de Chir. Militaire,* t. iv.

The treatment will consist, when the symptoms are urgent and threatening, in allowing the air to escape externally, either by enlarging the wound, or, if there be no wound, by introducing a trocar and canula, as in paracentesis thoracis, described a few pages further on.

c. Hæmo-thorax is hæmorrhage into the cavity of the pleura. This is so remarkably well described by John Hunter,* in his treatise on "Gun-shot Wounds," that we cannot refrain from quoting the following remarks. "In the cases of stabs, especially if with a sharp instrument, the vessels will bleed freely, but the external wound will collapse and cut off all external communication. If the lungs are wounded in the same manner, we must expect considerable bleeding from them, and this bleeding will be into the general cavity of the thorax (if the lungs at this part have not previously adhered there), and likewise into the cells of the lungs or bronchiæ, which will be known by producing a cough, and, in consequence of it, a bleeding at the mouth; for the blood that is extravasated into the air-cells of the lungs will be coughed up by the trachea, and by that means will become a certain symptom of the lungs being wounded; but that which gets into the cavity of the thorax cannot escape, and therefore must remain till the absorbents take it up, which they will do, if it is only in small quantity; but if in large quantity, this extravasated blood will produce symptoms of another kind."

The symptoms will depend, in a great measure, on the quantity of blood poured out within a definite period. Where the blood is effused immediately and in large quantities, there will be all the signs of internal hæmorrhage, and death speedily ensues, owing to the immense loss of blood, and suffocation from pressure on the lungs. This generally takes place in extensive wounds of the lung, but may also occur from wound of the large vessels in the chest, or even from wound of the intercostal vessels. The signs are, great oppression and uneasiness, restlessness, and sitting up in bed, with the body bent forwards; the countenance and surface become deadly pale and cold, and this is followed soon by syncope and utter prostration, the patient lying almost motionless in bed, with the legs drawn up, and an occasional heaving of the chest; with dilated pupils and glassy eye, clammy perspiration and weak fluttering pulse. Where the effusion of blood takes place slowly, recovery may be anticipated, and the symptoms of such effusion may be well illustrated from Hunter's work: he says, "The symptoms of these accidents are, first, a great lowness, which proceeds from the nature of the parts wounded, and perhaps a fainting from the quantity of blood lost to the circulation; but this will be in proportion to the quantity and quickness with which it was lost. A load in the breast will be felt, but more from a sensation of this kind than from any real weight, and a considerable difficulty in breathing. This difficulty in breathing will arise from the pain the patient will have in expanding the lungs in inspiration, and will also proceed from the muscles of respiration of that side being wounded; and this will continue for some time, from the succeeding inflammation: it will hinder the expansion of the thorax on that side, and of course in some degree of the other side, as we have not the power of raising one side without raising the other; and if wounded by a cutting instrument, the lungs of that side, not being able to expand fully, by the cavity of the thorax being in part filled with blood, will also give the symptoms of difficulty of breathing. The patient will not be able to lie down, but must sit upright, that the position may allow of the descent of the diaphragm, to give room in the chest."

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* *Hunter's Works*, by Palmer, vol. iii. pp. 567 et seq.

The diagnosis will depend on certain rational and physical signs: the rational are, firstly, the symptoms peculiar to all abundant hæmorrhages, such as syncope, vertigo, paleness, &c.; and, secondly, the functional disturbance of respiration, such as dyspnœa, short and hurried breathing, continual agitation and change of position. These symptoms are by no means conclusive, as they may be present without any effusion in the chest; and, on the other hand, patients may die of effusion of blood in the chest, without any serious impediment to the respiration. The physical signs are more to be depended upon: they are ascertained; 1st, by mensuration, which enables us to detect the enlargement of the chest on one side, the bulging of the intercostal spaces, and the diminished mobility of the ribs; 2d, by percussion, which will indicate dullness, or even a complete absence of all resonance; 3d, by auscultation, which will detect an absence of respiratory murmur, and by careful watching may even enable one to trace the effusion as it increases upwards; 4th, by succussion, either felt by the patient or produced by the Surgeon: where present, it is a good test, but it is often unattainable; 5th, by the appearance of ecchymosis in the lumbar region at the base of the chest, according to Valentin and other Surgeons, who describe it as taking place several days after the injury, and as extending from the angle of the false ribs towards the quadratus lumborum muscle, and as being of a deep violet colour, consisting of a transudation of the blood from the chest: however, this sign is not always present, and its absence may deceive the Surgeon, as happened to Sancerole, who declined to perform paracentesis because there was no ecchymosis, and yet, on examination after death, a pint of blood was found in the chest.

The treatment considered to be most judicious, is to close the external wound, and to allow the effused blood to coagulate if possible, and thus form a plug against further hæmorrhage; the effusion may prove to be inconsiderable, and provided no air has decomposed the blood, and there be only slight subsequent inflammation, the whole may become absorbed. Should, however, the effusion increase, and cause the above-named symptoms, paracentesis must be performed. Some recommend that the external wound should be kept open, and the patient placed in such a position as to enable the fluid blood to flow out, and to persevere in this measure; Ambrose Paré mentions several such cases as being successful. Others, again, prefer enlarging the external wound, so as to allow a more speedy escape for the effused blood; and this also has been attended with success in several instances. With regard to the attempts at its removal by means of a tube and pump, this method is attended with too great a risk, as it may injure the pleura and lung; and in respect to the injection of fluids into the chest to soften down and break up the clots, as has been actually proposed, this would be only substituting one effusion for another.

d. Penetrating wounds of the chest, complicated with the presence of *foreign bodies*, are always to be considered dangerous, inasmuch as they may set up inflammation and its consequences. The foreign body may be lodged in the parietes, or it may enter the pleural cavity and fall upon the diaphragm; or, again, it may pass into the pericardium; generally, however, foreign bodies enter the lungs or heart: in rare instances, especially if the substance be small, such as a bullet, it may become encysted, and remain quiescent for years. When the foreign body is lodged in the parietes, it must be extracted forthwith; but some difficulty may be experienced, as is recorded by Sabatier,* in the case of a man aged twenty-seven, who was struck very violently with a knife on the outer part of the fourth true rib; considerable coughing and spitting of blood ensued, and the symptoms were found to depend on the presence of a piece of the knife, which had pierced the rib, and was projecting some way into the thorax. So little of the foreign body was on the outside of the rib, and it was so fixed in the bone, that it could neither be extracted with any kind of forceps, nor even moved in the least with a leaden mallet, &c. M. Gerard conceived that an attempt might be made to extract the foreign body by pushing it from within outward. For this purpose, having put a steel thimble on his index finger, he introduced it into the cavity of the thorax, and thus succeeded in pushing out the piece of the knife. The patient recovered.† Where the foreign body has entered the pleural cavity, its presence is rendered very obscure in consequence of the speedy inflammation, and the almost necessarily ensuing empyema. Its diagnosis must be based upon, 1st, the penetration of a body, or ball, which has not passed out, and which is followed by thoracic symptoms; 2d, the absence of all signs of wound of the lung; 3d, irritation and inflammation of the diaphragm, from the ball or foreign substance gravitating to the bottom of the chest. In the case of policeman Thain, who was shot whilst bringing a prisoner from Hamburg, the symptoms were at first so slight that the wounds were regarded as being superficial; but after several days, sudden symptoms of empyema set in, together with great diaphragmatic pains and dyspnœa, and speedy death. On examination, one ball was found lodged in the intercostal space, another in the diaphragm, and a third was rolling about loose in the chest; but the lung was uninjured.

Larrey was more successful, for in one of his cases he made an incision into the chest, and, after evacuating about twelve ounces of pus, he succeeded in removing the ball by means of a polypus forceps, having previously ascertained its presence by the introduction of a sound. The general effects of such injuries are pleurisy, empyema, hectic fever, and death.

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* *Méd. Opératoire*, tom. ii.

† M. Vidal throws some doubt upon the propriety of this proceeding: he says, "It is not easy to introduce the finger armed with a thimble through an intercostal space; and even should it be practicable, great risk is run of the thimble coming off and falling into the chest on withdrawal of the finger."

When the foreign body has entered the lung, an unfavourable prognosis must be given; but some remarkable instances of recovery are on record: thus, Mr. South* mentions the case of a sailor, aged nineteen, whose chest was transfixed by the bolt of the trysail-mast (five inches and a half long, and two inches and a half wide). It entered between the fourth and fifth left ribs, fracturing the fourth about one inch and a half from the sternum, and made its exit between the eleventh and twelfth ribs, four inches to the left of the spine. There was difficult breathing, hæmoptysis, and threatening suffocation. The wound was closed by lint and strapping; he was freely bled both locally and generally, and put under the influence of mercury. He recovered and went to sea, was shipwrecked twice, and saved his life by swimming a considerable distance. He was seen ten years afterwards, and was then quite well. Velpeau† cites the case mentioned by Guillon, that of a convict who died at Rochefort, and in whose chest was found a part of a fencing foil; this had traversed the chest from one part to the other, and one of the extremities was implanted in the rib, while the other end was fixed in the spine; the middle part was in the centre of the lung, surrounded by calcareous deposit. It was ascertained that the wound took place fifteen years before, and there was no suspicion of the presence of a foreign body. In the museum of the Royal College of Surgeons of England is recorded the case of T. T., aged thirty-five: —the shaft of a chaise was forced between the ribs on the left side, through the cavity of the thorax behind the sternum, and made its exit between the ribs on the right side, without injury to the large vessels, lungs, &c. It was withdrawn, and he walked up two flights of stairs to bed; he had difficulty of breathing, pain and weight in the chest, vomiting and hiccough. He was bled very largely and blistered. He recovered, and lived for five years without inconvenience, when he began to suffer from difficulty of breathing and irregular action of the heart. He died ten years after the accident. The lungs were adherent to the parietes, and the pericardium entirely adherent to the heart, which latter was larger than usual.

The secondary complications or the consecutive effects of penetrating wounds of the chest have already been cursorily alluded to;

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* *South's Chelius*, vol. i. p. 441.

† *Presse Médicale*, tom. i. p. 151.

viz. pleurisy, pneumonia, and empyema. The symptoms, diagnosis, prognosis, and treatment of these diseases hardly come under consideration in this place, and the reader must therefore be referred on these points to the standard works on medicine; but, at the same time, the Surgeon must bear in mind that he is bound to possess an accurate knowledge of all these complications, so that he may be enabled to anticipate and detect the coming mischief, and thus check and repel it by suitable treatment.

However, it has been deemed advisable to enter into some further particulars respecting the operation for the relief of empyema and other effusions in the chest. This operation the Surgeon is sometimes called upon to perform, and it behoves him well to consider the general symptoms necessitating its performance, and the local manifestations which guarantee its probable success.

The operation is termed paracentesis thoracis or thoracentesis. Before operating, it is essentially requisite to make an accurate examination of the chest by means of auscultation and percussion, so as to determine the existence as well as the locality of the fluid or air in the chest; and then to select a proper situation for its evacuation, making use of appropriate instruments; as well as to guard against all difficulties which may occur during the operation.

There are many objections raised against the operation, but these, when carefully considered, do not in any way militate against its performance; the following are the chief circumstances urged against it: 1st, the necessary introduction of air into the cavity of the chest; 2d, the impossibility of entirely emptying the chest; 3d, the danger of taking away too great a quantity of fluid; 4th, the impossibility of breaking down old adhesions; 5th, the probable rupture of the air-cells and vesicles; 6th, the production of pleurisy and pneumonia; 7th, the more rapid reproduction of the fluid, after the operation; 8th, the possibility of the persistence of thoracic fistula.

These objections do not require to be entered into seriatim in the present essay; we shall therefore merely give the result of twenty-five cases, taken indiscriminately, in which it was performed at Guy's Hospital during a given period. Dr. Hughes in his summary remarks that "the operation was performed in twenty-five cases, in some once, and in others several times. Of these cases, thirteen may be fairly stated to have recovered, so far as regards the effusion into the pleural cavity: two may be justly mentioned as having at least partially recovered; one of these has, after seven years, a fistulous opening into the pleura, and the other has still some, though comparatively a very small quantity of fluid in the right pleura, but feels so much better as to be actually in search of employment in his profession. Ten have ultimately died of other diseases, generally connected with that for which the operation was performed, but entirely independent of its performance. Of these ten cases ultimately fatal, six have died of phthisis; one of gangrenous pulmonary abscess of the opposite side; one after three months of chronic pneumonia; one rather suddenly, with hydro-thorax in the other pleura; and one, a case of pneumo-thorax with effusion, of pneumonia and pericarditis."*

With regard to the situation in which the operation should be performed, the place of election, as it is called, three conditions have to be borne in view, viz. to procure a sufficiently depending opening, to avoid wounding the diaphragm, and the intercostal vessels. Mr. Cock, in his remarks appended to Dr. Hughes's paper in the *Guy's Hospital Reports*, observes, "In the great majority of instances the existence of the fluid would be most clearly indicated at the lateral and posterior part of the chest, in a position somewhat central between the upper and lower boundaries; and in every case which has come under my own hands I have had occasion to tap below the angle of the scapula, between the seventh and eighth ribs, or the eighth and ninth ribs, and at a point distant from one to three inches from the angles of the bones. Our incapability of judging of the exact positions of the diaphragm, and the alterations which are liable to occur about the floor of the chest from recent or old adhesions between the muscle and the base of the lungs, would lead me to deprecate the practice of making a low puncture. When we have the choice of two or three intercostal spaces, I would select the upper or, at any rate, the middle one, as the safest, and least obnoxious to those casualties which may induce a failure in our object: any advantage supposed to result from a depending opening can readily be obtained by adapting the position of the patient to our purpose."

M. Malgaigne's† instructions are, that, "to avoid the arteries, the middle third of the contour of the chest, midway between two ribs, is to be selected, and, in order to avoid the diaphragm, the third or fourth intercostal space, counting from below upwards, should be preferred; in France it is usual to select the third space on the left side, and the fourth one on the right, in consequence of the liver." He also states, that the required intercostal space can always be found, in thin subjects, by counting upwards from the twelfth rib; but in fat and well-developed persons there is much difficulty in recognising it; as a proximate guide it will be about six fingers' breadth below the inferior angle of the scapula; the best method is to take as a starting-point the last rib attached to the sternum, which is the seventh, and, on tracing it round the chest, it will give the sixth intercostal space above it, and the seventh below it.

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* *Guy's Hospital Reports*, series ii. vol. ii. p. 366.

† *Méd. Opératoire*, p. 532, 3^{me} édit.

The various modes of opening the chest are, 1st, by cauterisation; 2d, by incision; and 3d, by a trocar and canula, which is termed tapping, or paracentesis.

The proceeding by cauterisation is obsolete; the pain and great length of time necessary for effecting its purpose have rendered it quite inadmissible.

The operation of making an incision into the chest has been confined to the extraction of foreign bodies; and in this country it is seldom had recourse to for evacuating fluids from the chest, although it is preferred by some of the Continental Surgeons. It, however, sometimes leads to mischievous results, as liable to allow free ingress of air into the cavity.*

The operation by means of the trocar and canula is the one usually recommended and adopted. By Mr. Edward Cock's permission we are enabled to make use of the following extracts from his excellent paper in the *Guy's Hospital Reports*, where the whole subject is fully discussed. And, firstly, with respect to exploration previous to performing paracentesis. "Notwithstanding the perfection to which auscultatory diagnosis has been brought, and the exactness with which a practised ear is enabled to appreciate the deviations from natural structure and function within the thoracic cavity, the most experienced practitioner will sometimes be mistaken in his opinion, or, at any rate, puzzled by modifications of disease and conflicting evidence, which tend to obscure the clear signs of the presence of fluid. Under such circumstances it is always advisable, previously to tapping the chest, to explore the part in such a manner as shall, at any rate, inflict no injury on the patient, although its result may convince us of the inutility of a further operation. For this purpose, the grooved needle was invented and used; but, although applicable to many other purposes, it is at best a clumsy and inefficient instrument for exploring the chest, and frequently has left us as much in doubt after its withdrawal as previous to its introduction. The groove is so easily obstructed by the tissues through which the instrument passes, or by small particles of lymph, as to render the escape of fluid, which may really exist, a matter of great uncertainty. An instrument admirably adapted for exploration has been contrived by Dr. Babington. It consists of a needle contained in the smallest-sized canula; this is passed between the ribs into the suspected spot; the needle is withdrawn, and the escape of fluid from the tube at once indicates the existence and nature of the abnormal secretion. A further investigation, as to the size and direction of the cavity, may also be obtained by introducing a fine silver probe through the canula."

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* M. Vidal (*Traité de Path. ext.* 1861, tom. iv.) proposes a double operation; in the first instance, he makes an incision through the parietes to the pleura, and then allows the wound to be kept open until suppuration sets in, when he inserts a small fragment of caustic potash, so as to cause a slough, and thus evacuate the contents: this secondary operation may be performed by a bistoury or trocar instead of the caustic. He denominates it the operation "*en deux temps.*"

Secondly, with respect to the operation itself, Mr. Cock observes: "The trocar and canula which I have found best adapted for general use is about one-twelfth of an inch in diameter, and about two inches in length, exclusive of the handle. I prefer a circular to an oval instrument, as the former is more easily introduced and does less injury to the intercostal muscles, whose fibres are perpendicular to the long diameter of the oval canula. The small canula has many advantages; its introduction is easy, and attended with little friction; it gives but very slight pain, and it is calculated to elude the nerves and vessels: on its withdrawal, the opening which it has made becomes immediately and permanently closed, thus at once restoring the integrity of the cavity which has been entered; it is adapted to all ages, from the infant to the adult, and can hardly fail to find its way between the ribs, however narrow the intercostal space may be: again, it insures a slow and gradual evacuation of the fluid, and enables us to avoid the admission of air; at the same time allowing a better opportunity for the lungs to expand, and enable us more effectually to empty the cavity." Mr. Cock thus concludes: "It now only remains for me to describe the operation itself, which, as regards the pain it inflicts, is so trifling, that, by avoiding all unnecessary display and preparation, the patient may be led to consider it as little more than the sequel of the discipline to which he is occasionally subjected when it is considered essential to make a thorough examination of his chest; the same position of the body being alike adapted for the one process as for the other. It will be found most convenient to let the patient sit *across* the bed, so as to admit of his body being readily lowered and supported over its edge. The spot having been determined upon, it is advisable to make a small puncture in the skin, just at the upper edge of the rib, with a narrow-bladed lancet; through which opening the exploring needle and subsequently the trocar may be inserted. This preliminary step is not absolutely necessary; but as the skin is by far the most impenetrable and resisting of the tissues to be traversed, its previous division will render the introduction and withdrawal of the canula more easy, less forcible, and attended with a minor degree of pain and alarm to the patient. The exploring needle having been first introduced and the presence of fluid ascertained, the trocar and canula may then be carried into the chest through the same track, giving the instrument a slight obliquity upwards, which will enable it to clear the edge of the rib. The depth to which the trocar must be passed will of course depend much on the thickness of the parietes, the presence of fat, muscle, or œdema, for which due allowance should be made; and, in most instances, the penetration of the pleura will be appreciated by the sensation conveyed to the fingers of the operator, especially if the integument has been previously incised so as to diminish materially the friction.

"The remainder of the operation consists in getting rid of as much fluid as the strength and condition of the patient will bear, and carefully avoiding the admission of air into the cavity. On withdrawing the trocar, the fluid will at first be found to flow in a steady and equable stream, slightly augmented in force at each expiration. After the lapse of a shorter or longer period, the flow will become checked at each inspiration, and then the body of the patient should be gently lowered into a horizontal posture, and turned slightly on to the affected side, so as to bring the cavity directly over the opening; and in this position he should be duly supported by assistants. The fluid will now recommence flowing in an uninterrupted stream; and when it again begins to flag, a still further quantity may be obtained, if the state of the patient permit it, by directing an assistant to make steady and continuous pressure on the lower part of the chest, by grasping it on either side with the hand. This may be kept up for a period varying from a few seconds to a minute, until a continuous stream can no longer be obtained, when the canula should be immediately withdrawn. The greatest care should be taken to remove the tube, and thus close the opening, while the chest of the patient is yet in the grasp of the assistant; for, if he relax the pressure while the communication with the pleural cavity be still open, air will infallibly rush in.

"During the whole process of evacuation the unremitted attention of the operator should be directed to the stream of fluid, which he should never allow to become completely interrupted during the effort of inspiration. The admission of the slightest quantity of air is immediately indicated by a peculiar sucking noise, which cannot be mistaken, and which should be the signal for the prompt withdrawal of the canula. The wound requires nothing but the application of a small dossil of lint and a strip of plaster; and the patient may then be laid down in bed."

Of late years M. Chassaignac has introduced a plan of treatment for the healing of sinuses, and cure of deep-seated abscesses and extensive collections of matter, by what he terms "drainage-tubes." His plan consists in procuring an india-rubber tube, having a diameter of about one-sixth of an inch, and perforated at frequent intervals by notching it with scissors; and then introducing this into the abscess or sinus, so as to allow the matter continuously and uninterruptedly to exude through the perforations.

This method has more recently been employed in the treatment of empyema; thus, after the ordinary operation of paracentesis, a firm, long iron probe, somewhat bent, and having a strong piece of silk passed through its eye, is introduced into the opening and directed towards the lower and back part of the cavity; the end of the probe is then made to press against the sides of the thoracic walls, so that it may be felt externally between the intercostal spaces, when an incision is to be made upon it, and the probe brought through the opening thus made. Having secured the drainage-tube to one end of the silk, it is to be drawn through and brought out externally, and the two ends of the tube tied together outside.

The plan has been tried in this country on several occasions,* but has not found many advocates; the usual method as above given being generally preferred.

2. *Wounds of the mediastina, pericardium, and heart.* Wounds of the mediastina generally compromise the parts contained therein, such as the large vessels, nerves, œsophagus, &c.; they are, therefore, attended with serious results, and take on the characters of the major lesion. But now and then no important structure is im-

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* See *Med.-Chir. Trans.* vol. xlii. p. 231.

plicated, the weapon or instrument merely entering the loose cellular tissue of which the space is composed: a circumstance already alluded to when treating of foreign bodies in the chest, where a case was related of the anterior mediastinum being traversed from side to side behind the sternum, without any important structure being involved. This class of accidents is rare, and when they occur they are liable to be followed by inflammation of a diffused character, which is exceedingly prone to run on to suppuration, or may by contiguity set up pleurisy and pericarditis. In any case, a guarded prognosis must be given. The symptoms are exceedingly obscure, and are of a negative character only, viz. the absence of signs of pleurisy and pericarditis, and yet the presence of inflammatory symptoms. When suppuration takes place, it will often induce pyæmia, and death, without giving any external evidence of its existence. Some Surgeons have recommended the trephining of the sternum in cases where deep-seated suppuration is anticipated; but this measure can seldom be had recourse to, inasmuch as there is so much obscurity that no accurate diagnosis can be made. Where wounds of the mediastina are complicated with fractured sternum, ribs, and wounds of the lungs, heart, &c., the conditions are rendered much more serious.

Wounds of the pericardium are most frequently associated with other severe lesions, and seldom occur alone. They are generally complicated with wounds of the heart, internal mammary artery, diaphragm, œsophagus, &c., to which individual lesions reference must be made. But when the pericardium is alone involved, the wound will give rise to pericarditis; the symptoms, diagnosis, prognosis, and treatment of which must be learned from the standard medical works. Death need not be the immediate result of a wound of the pericardium, as proved by the case quoted by Sir A. Cooper; viz. that of a man who was wounded by a reaping-hook deeply through the cartilages of the ribs. The wound was small; the man had the appearance of one having sustained a dangerous injury, and in two or three days he complained of much pain in the region of the heart, and a quick, small pulse; he shortly began to swell, and could not lie down in bed: he lived for two or three weeks, and after death an effusion of bloody pus was found in the pericardium. Hennen relates a case, where there was a bayonet-wound of the pericardium and diaphragm, and where the patient recovered from its immediate effects, but succumbed to pneumonia three months after. The heart, in this case, was found adherent by long fibrinous bands to the pericardium.

Wounds of the heart are for the most part met with in gunshot wounds, but they may be seen in the other forms, namely, in the incised, punctured, or lacerated varieties.

Some authors have divided them into penetrating and non-penetrating wounds, according as they involve the cavities or parietes of the heart: this subdivision is of little practical importance, for both are attended with equally fatal results; death either taking place immediately from hæmorrhage or consecutively from acute pericarditis.

The symptoms are exceedingly uncertain, but the most important one is the presence of a lesion in the neighbourhood of the heart, with external bleeding, followed by all the signs of sudden internal hæmorrhage; this latter, however, is by no means so frequent or so considerable as is generally imagined, for the blood poured out into the pericardium soon coagulates, and thus prevents further effusion: again, the blood may make its way into the mediastina or pleuræ, and complicate matters. Dyspnœa is by no means a constant accompaniment, for it may be absent, or come on gradually, or become immediately intense. Dupuytren* observed a peculiar tremor about the heart, with weakening of the arterial pulsation, attended with an undulous crepitation or peculiar bruit. The pulse is often unequal, small, and intermitting. The acute pain in the sternal region, remarked by some, is neither constant nor certain. The position also of the patient is by no means characteristic, for some lie on the left side, others on the back, without inconvenience, whilst some cannot lie down at all. Auscultation is of but little assistance.

These wounds are generally considered mortal, death taking place immediately, or in a few days. Immediate death is generally caused by the sudden arrest of the heart's action, induced by one of two causes,—either by the accumulation of blood into the pericardium, pressing upon the heart and causing cessation of its action, or by a suddenly deranged cardiac innervation depriving the heart of its contractile powers, as seen in those cases of sudden death where little or no blood is found in the pericardium. There are, however, some instances of recovery. Dupuytren, indeed, takes a rather favourable view of these cases, regarding them as not being always mortal, and he instances the fact of acupuncture of this organ, adopted for the cure of cholera at Warsaw, being attended with comparative impunity: he also urges the possibility of a cure, as evidenced by animals killed in the chase, in whose hearts balls and cicatrices of former wounds have been found. Considering the ambiguity and uncertainty of the signs of a wound of the heart, recovery from such supposed occurrence can only be confirmed by the subsequent opportunity of post-mortem examination as in the case cited by Sanson,* that of a medical student who recovered completely in twenty-eight days; he was wounded on the left side of the chest immediately below the nipple, and from the attending symptoms it was conjectured that one of the cavities of the heart had been penetrated; at the autopsy, some lengthened period afterwards, a cicatrix in the heart was visible. The case cited by Velpeau† is still more explicit; it is that of a coalman, aged fifty, who died in the Hospital of the Faculty; he had, nine years previously, received a wound in the left side of the chest from a table-knife: the pericardium was found largely opened and adherent to the parietal cicatrix; fibrous lines traversed the whole thickness of the right auricle, at a point corresponding to the breach of surface in the pericardium.

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* *Leçons orales de Clin. Chir.* 2^me^ éd. 1839, tom. iii. pp. 201 et seq.

The duration of life after such wounds is variable; and this variation is by some considered to be due to the part of the heart which is involved: thus, Ollivier d'Angers‡ gives the following summary of sixty-one collected cases:

In 29	cases	the wound was in the	right ventricle.
12	,,	,,	left ,,
9	,,	,,	both ventricles.
3	,,	,,	right auricle.
1	,,	,,	left ,,
7	,,	the wound involved either the base or apex simply.	

Of these twenty-nine cases of wounds of the right ventricle, with the exception of two, all lived not less than two days; viz. 4, 5, 8, 9, 13, 15, 20, 23, and even 24 days, respectively.

M. Jamain (*Thèse de Concours*, Paris, 1857) has extended this inquiry, and has endeavoured to determine the relative frequency of wounds of the different regions of the heart. In a collection of 121 cases there were—of wounds of the

Right ventricle	43	Right auricle	8
Left ,,	28	Left ,,	2
Apex and base of heart	7	Interventricular septa	2
Both ventricles	9	Both auricles	1

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* See Nélaton, *Pathol. Chir.* tom. iii. p. 472.

† *Traité d'Anatomie Chir.* tom. i. p. 604, 2^{me} édition.

‡ *Dictionnaire de Méd.*, art. "Cœur."

Left auricle and ventricle	1	Coronary artery	2
The whole heart	1	No precise indication	17

In the 121 cases, instant or very rapid death was observed in 21 cases, thus distributed:

Right ventricle	6	Left side of heart	1
Left ,,	6	Heart crushed	1
The two ventricles	4	Wound of heart not indicated	1
Non-penetrating wound	1	Coronary artery	1

The duration of life does not bear any proportion to the extent of the wound; thus in the well-known case quoted in most French works of the celebrated first grenadier of France, who received a lance-wound between the sixth and seventh ribs, which implicated the anterior parietes of the left ventricle of the heart, it caused immediate death; and on examination half an hour afterwards, the pericardium presented a rent of four to five centimetres, and contained but little blood; the wound in the heart was very small and very superficial. Again, in the year 1728, one of the ladies of the Sardinian court ran a long gold needle into the chest of her husband, whilst asleep, and caused his sudden death: on examination, the right ventricle was found pierced through and through. The thinness of the parietes of the auricles is not the cause of a more rapid death; thus in the case of the Duc de Berri, whose right auricle was traversed by a saddler's awl, he lived eight hours; and in the case quoted by Blagny,* where the right auricle was wounded, the patient survived five days.

The direction in which the wound is made will materially affect the duration of life; thus, if made in the course of the muscular fibres, there may be little or no hæmorrhage; but if the heart is cut across, the edges will separate to a great extent, and sudden death occur from the immediate gush of blood.

The following recorded cases are instances of long survival after wounds of the heart. Breschet† quotes the case of a man who was thrust against a wall by the shaft of a cart, causing fracture of the sternum and the fourth, fifth, and sixth ribs, and laceration of the pericardium, with superficial lesion of the left ventricle to the depth of one-third of its substance; he lived twelve days: on examination, there was no fluid in the pericardium, but a large quantity of blood in the left pleura. Ferrus† relates the case of a man living twenty days with a skewer traversing the heart from side to side. David and Steward found a piece of wood, three inches long, in the right ventricle of a boy, who lived five weeks after the accident. Dupuytren, in his *Leçons Orales*, records in full three cases of wound of the heart; one living nine days, the second three weeks, and the third three days: their perusal will well repay the attention of those interested in such matters. There is a remarkable case of survival for twenty-four hours, related by Dr. Babington:* a marine fell upon his bayonet, which entered the abdomen, passed through the sigmoid flexure of the colon, through the stomach, the left lobe of the liver, the diaphragm and pericardium, and traversed the heart near the tricuspid valve; then penetrated the lung, and made its exit at the anterior part of the chest between the second and third ribs on the right side.

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* *Journal de Médecine*, an. xl.

† Breschet, J., *Repertoire d'Anatomie et de Physiologie*, 1826, tom. ii.

Much further detail and many curious cases may be found in works on Military Surgery. The popular notion of persons springing up in the air, when shot through the heart, is not verified by facts.

The treatment will be mainly directed to prevent and arrest internal hæmorrhage, by absolute repose, local and general employment of cold, and early venesection to relieve the heart; and to allay the excited action of the heart by the administration of belladonna and digitalis internally. Where blood has become effused into the pericardium, it has been suggested to lay open the pericardium, and evacuate the blood and coagulated mass, and thus relieve the oppression of the heart; but although this has been recommended, it has not yet been put in practice, probably owing to the difficulty of distinguishing internal hæmorrhage into the pericardium from hæmorrhage into other important cavities.

Paracentesis of the pericardium is seldom called for; it has been performed between the fifth and sixth intercostal spaces, between the ensiform cartilage and the seventh rib, and by means of trephining the sternum. The operation is best performed in the fourth or fifth intercostal space, either by direct puncture or by incision and subsequent puncture, as in paracentesis thoracis: the precautions and mode of performance are the same.

3. *Wounds of the vessels of the thorax.* Wounds of the intercostal artery are occasionally met with; thus the vessel has been injured

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* *Medical Records and Researches*, p. 59.

in the unskilful performance of paracentesis, and in the making of incisions into the chest without due anatomical knowledge; it has likewise been wounded in cases of fractured ribs, and in penetrating wounds of the chest. The effects will be either external or internal hæmorrhage. The symptoms of internal hæmorrhage have been already detailed at pp. 364, 5, to which reference must be made. This occurs generally in cases of punctured wounds or stabs, where the blood, not being able to escape externally, passes into the pleural cavity. Where the hæmorrhage takes place externally, in consequence of a large and direct wound, a pulsating jet of arterial blood may be observed, which will immediately apprise one of the nature of the injury; but, generally speaking, the wound is small, and the blood escapes continuously, and not *per saltum*, so that much is lost before the means of checking it can be had recourse to. Sometimes the blood, instead of escaping externally, passes into the tissues external to the chest, as related in a case by Mr. S. Cooper.* A young gentleman had been wounded by a penknife, severing an intercostal artery about two inches from the vertebral column; about eight ounces of blood immediately flowed from the external wound, followed by an enormous extravasation of blood under the muscles of the back, intense pain, and high symptomatic fever. In a few days, in consequence of suppuration having taken place, an opening was made, and about a gallon of fluid was discharged, composed partly of pus, but chiefly of putrid blood. The case proved tedious in consequence of the formation of deep sinuses, and frequently life was in great danger; but in the end the young gentleman recovered. It has been suggested, in order to facilitate the diagnosis, to introduce into the wound a piece of card, which will allow the blood to flow out externally along its surface, if the artery be wounded and internal hæmorrhage suspected.

The treatment of wounds of the intercostal artery will be the enlarging of the external wound, and securing the divided ends of the artery by ligature; but this is by no means easy. Mr. Harrison, in his well-known work *On the Arteries*, thus alludes to this point: "In cases of wounds of the thorax, in which an intercostal artery has been opened, the patient may lose a considerable quantity of blood before the Surgeon can stop the hæmorrhage; the artery lies so deep, and the intercostal space is so confined, that it is almost impossible to hold the artery with the tenaculum or forceps, for the purpose of applying a ligature upon it. The student may form some conception of the difficulty of this operation if he expose an intercostal artery in the dead subject, by dissecting from the surface. This may also lead him to reflect upon the plans which have been proposed for securing this vessel where a ligature cannot be directly applied; he may endeavour to pass a small curved needle round the artery, directing it from within outwards; and should this measure be attended with much difficulty, from the smallness of the incision, he may observe how much it will be facilitated by enlarging the opening. Suppose it were impracticable to pass a ligature round the artery in the living subject, he may learn from his dissection the possibility of compressing it by other means; thus, by placing a ligature on a piece of sponge, and introducing the latter through the wound into the chest, then withdrawing the ligature so as to cause the distended sponge to make pressure of the vessel against the rib, and securing the thread externally over a compress placed over the wound, he may by these means restrain the bleeding."

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* *Surgical Dictionary*, p. 1491, 7th edition.

A variety of methods have been suggested, such as the passing of a ligature or wire around the rib, so as to include, not only the artery, but also the bone and soft parts; the introduction of metal or ivory plates into the chest, drawn from within outwards by means of riband or silk thread, so as to compress the artery against the rib. All these methods are unjustifiable, as they are liable to excite severe inflammation of the pleura and lung. Assalini* prefers simply cutting the artery across, so as to allow it to retract; and if this plan fails, he recommends the wound to be closed; should the blood find its way into the chest, it is true the consequences will be serious, but not fatal; and if the symptoms require it, the operation for empyema may afterwards be performed. A small quantity of effused blood, however, may be absorbed, and no such proceeding be requisite. Dr. Hennen† says, "Unfortunately we but too often are disappointed in finding the source of the hæmorrhage, and here judicious pressure is our only resource. In some very slight cases I have used the graduated compress with success; but if the sloughing is extensive, nothing but the finger of an assistant, relieved as occasion may require, and pressure directed upon a compress placed along the course of the vessel, or so disposed as to operate upon its bleeding orifice, will be of any avail."

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* *Manuale di Chirurgia*, pp. 58, 59.

† *Military Surgery*, p. 377, 2d edition.

Wounds of the internal mammary artery. The protected situation of this vessel renders its injury exceedingly rare; still there are several cases on record. M. Tourdes has written a special monograph on this accident in its medico-legal aspect: the result he arrives at is, that the lesion occurs on the right and left sides in equal proportion; that in more than half the cases it is accompanied with section of the cartilages, and that this section always exists when the vessel is wounded below the fourth rib: he also remarks that all wounds situated at the sides of the sternum from the first to the seventh ribs, and of sufficient depth, should always engage our attention, and be regarded as suspicious.

The results may be: 1. external hæmorrhage; 2. hæmorrhage into the anterior mediastinum; 3. hæmorrhage into the cavity of the pleura; 4. hæmorrhage into the cavity of the pericardium; besides, it is not unfrequently complicated with wound of the lung, heart, or diaphragm.

The symptoms will be those of hæmorrhage, in addition to those of any complication which may exist.

The prognosis is always unfavourable; much internal effusion of blood takes place, and death generally ensues from the hæmorrhage.

The treatment consists in compression of the vessel in the same way as above prescribed in wounds of the intercostal artery, and in the application of a ligature on the vessel; although this latter proceeding is exceedingly difficult. In the first three intercostal spaces the artery may be secured with ease; in the fourth space it becomes difficult to reach; the operation is very difficult in the fifth, and almost impracticable in the sixth space. It is performed by making an incision for two inches along the side of the sternum, and in an oblique direction from above downwards, and from without inwards, forming with the axis of the body an angle of forty-five degrees; the centre of the incision to be three or four lines from the border of the sternum. Having divided the skin, cellular tissue, and origins of the pectoralis major muscle, the intercostal space is brought into view; the intercostal muscle is now to be carefully divided upon a director, and the edges drawn apart by retractors, when the artery becomes exposed.

Baron Larrey* says that he has seen several cases of wounds of this vessel, and he proposes simply to close the external wound so as to allow of coagulation, and by this means to compress the vessel.

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* *Clinique Chir.* t. iv. p. 101.

He relates three cases of this injury. The first case was a sabre-thrust, which entered the chest for an inch and a half, dividing the cartilage of the seventh rib close to the sternum; there was great effusion of blood, and very severe symptoms, so that it was thought necessary to lay open the wound and evacuate the blood; the man made a good recovery. In the second case, a knife entered above the cartilage of the fifth rib on the left side; the wound was closed, much effusion of blood followed, and severe symptoms set in, so much so, that a puncture was obliged to be made, whereby a pound of blood and clot was evacuated; but the patient lived only twenty-one days. In the third case, a knife entirely divided the cartilage of the fourth rib; this was followed by much hæmorrhage, which ceased, and the wound was closed; in a few days signs of internal hæmorrhage ensued, paracentesis was performed, two and a half pounds of blood evacuated, and a recovery resulted.

Wounds of the larger vessels of the chest are for the most part fatal, and are attended with all the symptoms of a rapid internal hæmorrhage, death almost invariably resulting immediately, or in a few hours afterwards. Some rare cases of survival after such wounds are, however, on record; thus Dr. Heil* details a case in which a patient recovered and lived for twelve months after receiving a stab which penetrated the ascending aorta.

Pelletan† writes: "In May 1802, a young man was brought to the Hôtel Dieu, who, in a duel, had been run through with a foil, which entered above the right nipple and came out at the left loin: the most alarming symptoms were apprehended, but several days elapsed without any serious complaints taking place. The patient was bled twice, and kept on very low regimen. Every thing went on quietly for a fortnight, when he began to complain of severe pain in the loins, which was relieved by the warm bath. He seemed to be recovering; he got up, and went to walk in the garden allotted to the sick; but the pain in the loins quickly returned, attended with difficulty of breathing, with constipation, and wakefulness. He became now very impatient and out of temper for not being relieved. On the 15th of July, two months after the accident, there was remarked a deformity of the spine, about the eighth dorsal vertebra. The patient grew rapidly worse, and died in the utmost agony, saying that he felt suffocated; and tore off his shirt, so that his chest might be free from pressure of all kind. On the body being opened, the right side of the chest was found full of blood, coagulated in various degrees; and an opening, the diameter of which was equal to that of a quill-pen, was detected in the aorta, above the crura of the diaphragm. All the adjacent cellular tissue was injected with blood, and three of the dorsal vertebræ were found carious. There was no mark of injury perceptible in any of the thoracic or abdominal viscera."

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* *Henke's Zeitschrift*, 1837, t. ii. p. 459.

† *Clin. Chirurgic.* t. i. p. 92.

Breschet* relates the case of a wound of the vena azygos, a little below its entrance into the superior cava, which was followed by considerable effusion of blood, and death resulted on the third day from compression of the lung by the effused blood.

4. *Wounds of the œsophagus.* These are, for the most part, complicated with other injuries, and are more appropriately considered with wounds of the neck. However, it has been considered advisable to draw attention in this place to wounds of the thoracic portion of the œsophagus, by referring to the following case.†

A man, aged twenty-four, was stabbed by a bayonet in the anterior and superior part of the chest; it entered between the third and fourth right ribs, one inch from the sternum. He fled from his assassin for half a mile, without feeling any pain; on reaching home he had coughing and spitting of blood, and in an hour after the accident experienced inexpressible anguish; he was lying on his right side, suffering from the least movement, and complaining of intense pain all along the right side of the chest, as far as the haunch. At each inspiration and cough, air escaped through the wound, sufficient to blow out a candle seven or eight inches distant. On the second day, respiration was much embarrassed, but the spitting of blood was arrested after a third venesection. On the third day, on removing the dressings there escaped a large quantity of red fluid, of less consistence than blood; the respiration was more free. Much fluid ran out during the day, and at each time of dressing, and it was suspected to be the fluids swallowed. Oily and coloured drinks were given, which in due time stained the dressings. The patient was now prevented taking any thing by the mouth, and was fed by nutritious enemata. For four days nothing escaped through the wound, and he made a gradual recovery. Subsequently, he had signs of a large effusion in the chest, when on the thirtieth day he vomited and rejected a large quantity of pus; this flow of pus lasted for another fifteen days. He ultimately recovered.

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* Op. cit.

† Boyer, *Traité des Maladies Chir.* tom. vii. p. 220.

Contusions of the chest, followed by lesion of the contents without any external wound, may be associated with the following effects: firstly, pleurisy, and in rarer instances pneumonia, which come under the more immediate cognisance of the physician: secondly, inflammation of the cellular tissue of the mediastina, running on to suppuration, and producing dyspnœa from pressure on the lung, or causing disease of the sternum, in rare instances assuming the form of a pulsating tumour, owing to the contiguity of the heart, and simulating aneurism.*

Thirdly, such contusions may be attended with rupture of the lung; this last accident is rare, but several well-authenticated instances are on record. The symptoms, diagnosis, prognosis, and treatment will be the same as detailed in wounds of the lung, but in these cases there will be an additional obscurity, viz. the absence of any external lesion, or fracture of the ribs. Watson, in his work *On Homicide*, relates the case of a carter, who, being somewhat intoxicated, was thrown off his cart, and the wheel passed obliquely over his chest; he expired shortly after. There was no external wound, and no fracture of the ribs; but a laceration of the right lung near to the origin of its vessels, and there were three pounds of blood in the right cavity of the chest: the liver was also lacerated, and blood effused in the abdomen.

M. Gosselin, in *Mém. de la Soc. de Chir. de Paris*, vol. i., has fully entered into this subject, and adduces two cases of ruptured lung from external violence without any external wound or fracture of the ribs, both of which recovered: he remarks, that when a rupture takes place, there may be a solution of continuity of the pulmonary vesicles without wound of the pleura; or there may be a tearing of the lung-tissue, as well as of the pleural envelope; in the latter instance, air and blood will escape, and the symptoms will be those of hydro-thorax; there will be dullness at the lower part of the chest and sonority at the upper part, a mucous râle or gurgling opposite the site of the rent, metallic tinkling, dyspnœa, frequent respiration, spitting of blood, and sometimes cutaneous emphysema.

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* Sir A. Cooper mentions the case of a medical student who was supposed to have aneurism, but matter made its way through the sternum, and a thorough recovery was effected.

In the *British Medical Journal* for March 1859, there is related the case of a boy, aged seven, who was struck down by a cab, the wheel passing over his chest. He complained of great pain in the belly and on the left side of the chest, which was dull and gave no evidence of respiratory murmur. About four hours after, there was considerable distension of the intercostal spaces, and great dyspnœa; he died on the following day. The ribs were found uninjured, but the lung was extensively lacerated, and the pleural cavity full of blood.

A similar case occurred at Guy's Hospital, but death ensued in two hours, in consequence of the complication of ruptured liver; the lung was ruptured at the lower edge of the middle lobe of the right side, to the extent of three inches; the pleural cavity was filled with air and some ounces of blood, and the lung partially collapsed.

Pneumonia or pleurisy may supervene. The prognosis is unfavourable, as the laceration is generally extensive; still, death is not always the result, as seen by the recovery of the cases brought forward by M. Gosselin.

The rupture may be direct, viz. at the seat of injury, or indirect, at some distance off; and M. Gosselin asks, how are we to explain the rupture of the lung without any fracture of the ribs? Is it from shock, as is observed in injuries of the brain? He thinks not: the elasticity and mobility of the ribs are too great, and they resist such shock, without implicating the lung-tissue. Again, is it from extensive and long-continued pressure of the ribs forcing the lungs against the spinal column? The lung is spongy, soft, and composed of cells freely communicating with the bronchi and trachea, and, when compressed at one part, the air escapes into another; and thus the lung accommodates itself and does not tear: on the other hand, in order to press the lungs against the spine, there must be enormous force and pressure; and even then it is impossible without fracture of the ribs.

M. Gosselin offers the following explanation as to the probable cause:—that at the time of the injury, when the chest receives the violence, the lungs are suddenly filled and distended with air by a full inspiration, and the air, prevented from escaping by occlusion of the larynx, thus becomes pent up in the lung-tissue, and the lung not being able to recede from the superincumbent pressure, its tissue necessarily gives way.

Fourthly, severe contusions of the chest may be followed by cerebral congestion, owing to derangement of the circulatory and respiratory functions; thus, heavy weights falling upon the chest, or undue and prolonged pressure on the ribs, preventing their free action, as in the fall of earth whilst excavating, may arrest the respiratory functions and induce venous congestion and asphyxia. There may be in consequence epistaxis, ecchymosis of the eyes, congestion of the brain, &c.

Fifthly, contusions may give rise to pericarditis and carditis, as evidenced in the following instances:

A child received a blow on the chest, causing great pain and very violent palpitation; he had repeated attacks of hæmoptysis, and died at the end of six months. There was pericarditis and carditis, and a livid sphacelated spot on the heart, which extended into the cavity of the ventricle.

Blancard* relates the case of a peasant who was thrown under a cart; he had immediate pain in the chest, and dyspnœa, with a feeling of compression of the heart; after four days he went to work, but soon after had violent fever, oppression, and delirium, with insomnia, extreme thirst, and frequent syncope. He died on the eleventh day. The pericardium was full of sanious pus, and the parietes of the auricles, here and there, ulcerated and softened.

Sixthly, contusion of the chest may be complicated with injury to the heart, causing a rupture of its fibres or its valves. The symptoms and prognosis will be the same as those detailed in WOUNDS OF THE HEART. Death, however, in these cases, is almost always instantaneous, although some have lived for several hours. There is a preparation of a lacerated heart of a child in the museum of the Royal College of Surgeons, Edinburgh;† in the description of which it is stated that a cart-wheel had passed over the chest and occasioned instant death, but there was no external wound or fracture of the ribs. Dr. Christison‡ mentions two cases from violence, the one caused by a fall, the other owing to a blow. Mr. Gamgee§ has collected 27 published cases of the kind; 12 occurred on the right side, of which 8 had rupture of the ventricle, and 4 of the auricle; 10 occurred on the left side, of which 3 were of the ventricle, and 7 of the auricle. In half of the cases the pericardium was intact.

ALFRED POLAND.

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* *Lexicon Med. Renov.* 1735.

† See *Trans. Edin. Med.-Chir. Soc.* vol. i.

‡ Watson *On Homicide*, p. 96.

§ *Researches in Pathological Anatomy and Clinical Surgery*, 1856.

INJURIES OF THE ABDOMEN.

INJURIES of the abdomen are accidents generally of a grave character, with the effects of which the Surgeon has frequently, but too often hopelessly, to combat. In order that a careful, and, it is hoped, a comprehensive examination of the characters and the results of these injuries may be laid before the reader, it is intended to consider the following points:

- *a.* Contusion of the parietes
  1. Without rupture of viscera.
  2. With rupture of viscera.
- *b.* Wounds.
  1. Wounds of the parietes without protrusion of viscera.
  2. Wounds with protrusion of viscera.
  3. Wounds of viscera.
  4. Fistulæ; gastric and biliary.
  5. Artificial anus.
- *c.* Foreign bodies in
  1. The stomach.
  2. The intestines.
  3. The cavity of the peritonæum and in the abdominal wall.

CONTUSIONS.

Contusion of the parietes of the abdomen, without rupture of any of the abdominal viscera, may prove, according to the violence of the injury, of serious importance, or trifling in effect. But even a slight contusion of the abdominal wall must not be regarded too lightly. A very slight blow on any portion of it may produce symptoms sufficient to excite alarm, or demand most careful consideration in treatment; and therefore, in any case of a blow or other violence received on the abdominal wall, the examination of the patient should be conducted with extreme caution and judgment, in order that the *utmost* amount of mischief that may possibly result from such an accidental cause should not be overlooked. In such an examination it should ever be borne in mind, that the previous general condition of the part injured, will, to a certain extent, influence the results; and that in judging of these results we must look to many relative circumstances: whether the abdomen be thickly covered with fat, or rendered small by general emaciation; whether the contents of the stomach and intestines be considerable in quantity, or whether the accident has occurred many hours after a meal. These and other circumstances must be fully inquired into, in the first instance, before we can decide on the probability, as well as on the extent, of deep-seated mischief. Nor will it prove a small satisfaction if we can arrive at something like a favourable conclusion, that the bruise of the integuments is not attended with rupture of any viscus.

Contusions of the abdominal wall (by which term are intended merely the soft tissues surrounding the cavity of the abdomen) are various in their primitive, as well as in their subsequent, conditions. Such contusions are usually the result of falls or blows on the abdomen; of cart-wheels passing over the body; of shafts of carts or carriages forced against it; or of a quoit or cricket-ball striking it. Such accidents will frequently be immediately followed by intense pain, faintness, and vomiting, without any injury of the deeper tissues having occurred. A quoit, in falling towards the ground, accidentally struck a boy on the epigastrium. The pain immediately experienced was agonising for some seconds, and was attended by great difficulty in breathing. The boy was very faint subsequently. Rest on a sofa for the afternoon was the only treatment adopted, and on the following day he appeared quite well, nor did any ill effects ensue.

There appears to be a prevalent and a rather popular idea, that *sudden* death may result from a blow on the epigastrium or abdomen, without any injury of structure, external or internal, being detected on examination after death. It is therefore very desirable to inquire if any evidence we possess justifies us in accepting the statement, that death may follow *immediately* upon a blow, without any actual appreciable alteration or injury of parts contained within the cavities of the abdomen or thorax. No one will dispute for a moment, that a very violent concussion of the abdominal viscera may be followed by *sudden* death; but a very violent concussion would act, not only as a *shock* to the nervous system, but would also, without doubt, produce marked evidences of injured tissues, readily recognised on examination after death. But are there not cases of sudden death reported to have followed blows on the abdomen, in which cases no evidence of altered tissue nor any indications of bruise could be found? This question we fear we cannot answer quite satisfactorily. "There is no medical doubt that a person may die from what is termed shock," says Dr. Taylor, "without any marks of severe injury being discovered on the body after death. We have examples of this mode of death in accidents from lightning, or from severe burns or scalds, in which the local injury is often far from sufficient to explain the rapidly fatal consequences. As instances of this form of death from violence, may be also cited those cases in which a person has been suddenly killed by a blow upon the upper part of the abdomen or on the pit of the stomach, which is supposed to operate by producing a fatal impression on the cardiac plexus. Whether this be or be not the true explanation, the fact itself is undisputed; it is certain that a person may die from so simple a cause without any appearance being produced, externally or internally, to account for death. On the skin, there may be some marks of abrasion or slight discoloration; but, as it has been elsewhere stated, these are neither constant nor necessary accompaniments of a blow. Convictions for manslaughter have taken place when death has been produced under these circumstances."* In confirmation of these remarks, Dr. Taylor refers to a case reported by Mr. Wood of Bury, Lancashire, in vol. xliv. p. 213 of the *Medical Gazette.* We have copied the general particulars of this case, that our readers may draw their own conclusions respecting it. "On the evening of July 6th, 1849," writes Mr. Wood, "I was called to see David Bates, æt. 31, who had suddenly fallen in the street whilst fighting. I found him dead, and ascertained that about a quarter of an hour had elapsed since he fell. He was warm, and covered with perspiration; his face pale and cadaverous; his eyes closed, the pupils widely dilated."

Nineteen hours after death, Mr. Wood made an examination of the body, of which the following are the notes.

"*External appearance.* Escape of bloody serum from the nostrils; black ecchymosed patch on the bridge of the nose; contusion under the right ear; slight lividity on the upper part of the chest; contusion on the left elbow. On turning the body on the face, about an ounce and a half of dark grumous blood escaped from the nostrils.

"*Abdomen.* Old adhesions of the omentum in the right iliac region; arch of the colon rather dark; stomach contained some half-digested matter, and presented numerous ecchymosed points in the mucous membrane of the posterior surface at the cardiac extremity; liver rather small, and presented a slightly mottled appearance on the surface; kidneys, spleen, and pancreas healthy.

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* *Medical Jurisprudence,* p. 299; 1858.

"*Thorax.* The lungs collapsed on opening the chest; were rather darkly mottled, but healthy; congested posteriorly. Old adhesions between their posterior borders and pleura on each side. Heart, healthy; contained very little blood, which was fluid. The blood generally in a fluid condition.

"*Head.* Dura mater slightly congested. *Pia mater on the surface of the brain and in the sulci between the convolutions excessively congested with dark fluid blood.** No fluid in the ventricles. Substance of brain healthy, and without any lesion.

"At the inquest, three witnesses stated that Bates was intoxicated, though not so much so but that he could walk and stand unsupported by others,—that he talked a good deal and challenged his antagonist to fight; that in two or three minutes, the combatants being within half a yard of each other, Bates received a *left-handed blow, but apparently not a severe one, in the pit of the stomach;* that he fell on his face, according to the first witness, within half a minute; according to the second witness, in a moment or two; according to the third witness, instantly, dead. The first two witnesses also swore that, in their opinion, he moved his arms in a fighting attitude after being struck, and before he fell; as they thought, with an intention of continuing the fight. The third witness, however, swore that there was no action of this kind. On raising him from the ground, which was done immediately by the witnesses, a few drops of blood escaped from his nostrils, but he was dead; and all the witnesses agreed that no indication of life was observed in him after he fell. On being asked to give my opinion as to the cause of death, I stated that, inasmuch as the post-mortem appearances did not furnish any other explanation, I unhesitatingly attributed it to concussion of the solar plexus, occasioned by the blow, which, according to the evidence of the witnesses, Bates had received in the epigastrium." Mr. Wood further states, that Mr. P., a medical gentleman associated with Mr. Wood in making the post-mortem examination, who also heard the general evidence, stated, "The condition of the membranes of the brain proved a great amount of excitement, and that this alone might have been the cause of death." The jury, having heard conflicting medical opinions, gave the benefit of the difference to the prisoner, and returned as their verdict, that Bates died from over-excitement.

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* The italics are ours throughout.

Mr. Wood adds, "The opinion expressed by Mr. P. appears to me inconsistent with all medical experience. I think all experienced pathologists admit that, in cases where sudden death from violence or accident occurs to an intoxicated person, it is usual to find the pia mater turgid with dark fluid blood, as was observed in this case. This at once disposes of the only appearance existing in the body on which Mr. P. could ground the opinion he expressed. There was no evidence adduced of any extraordinary excitement in Bates previous to fighting; he was drunk and quarrelsome, but showed no symptoms of oppression of the brain. He fell immediately after receiving a blow in the epigastrium; and the manner of his death, that is, the instant extinction of life, does not accord with our experience of death occasioned by any form of apoplexy, an attack of which coincident with the blow, though quite within the range of possibility, might fairly be considered very remarkable. I regard the case as an unequivocal instance of death from a blow on the epigastrium."

Before expressing any opinion on the observations of Dr. Taylor, or upon the latter case and Mr. Wood's remarks upon it, the author must first draw attention to the following extract from a prize-essay *On Wounds and Injuries of the Abdomen*, by Mr. Alfred Poland, to whom the author is greatly indebted for the privilege of having been allowed to make use of this valuable manuscript:

"The epigastric and upper part of the umbilical regions contain such numerous and such vital structures, and, above all, the solar plexus and its numerous branches, of such high organic importance, covered in by soft parietes little capable of resisting and transmitting external shocks, that it is not to be wondered at that death should be an immediate result of a blow in these regions.

"On inspection of such cases, no appreciable morbid changes can be detected, not even the trace of ecchymosis about the parts.

"A blow on the pit of the stomach—a hit in the wind, as it is called—does not act so much on the diaphragm as it does upon the nerves: occasionally, though not always, there is intense pain; but sometimes the shock is so severe as at once to arrest the action of the heart, and the man is killed as it were with a blow even of a trifling kind. Sir A. Cooper used to state a case which came to his knowledge, though he was not an eye-witness of the occurrence. Two men were working near the East India House, one of whom had a heavy load which he was wheeling along; his comrade said to him, 'That is too much for you; stand aside, and let me—a better man—take it.' He accompanied this with a slight blow on the scrobiculus cordis, and the man immediately let the barrow fall from his arms. He felt a severe shock; the sudden impulse made so strong an impression on the heart's action as to stop it, and, without complaining of pain, the man died on the spot. On examination, no lesion was discovered. In a case of manslaughter tried at the Central Criminal Court in August 1841, death had been caused in this way during a pugilistic combat. The man received a blow on the stomach, and fell dead. As there were no marks of external injury, the Surgeon thought the man had died of apoplexy. In the latter of these cases there is no detail of the post-mortem to arrive at a satisfactory conclusion. Another case, somewhat more conclusive, but complicated with pregnancy, occurred in March 1835, on the Norfolk Circuit, at Cambridge. John Bond was indicted for the murder of his wife by beating her with a codfish. The prisoner, who was intoxicated, desired his wife to cook the fish, which weighed about 6 lbs. She refused because it was not a seasonable hour, and there was no fire. He seized the fish, and then beat her over the abdomen for some minutes with extreme violence. She died in a short time afterwards; and on a post-mortem examination the marks of many bruises were found on the body. The deceased was in the last month of pregnancy, and, in the opinion of the practitioner, her death was occasioned through the shock imparted to the system by the violence of the prisoner." *

The cases brought forward by Mr. Poland to illustrate the theory generally received as to the nature of these accidents, are only three in number. No one acquainted with Mr. Poland's industry, can suppose that he would have overlooked records of such a class of interesting cases, had there been many reported; and all who are acquainted with the rich stores of information contained within the case-books and museum of Guy's Hospital, as well as the immense practical experience afforded, in the course of years, in its wards, will feel satisfied that had such accidents, illustrating the theory advocated heretofore, been of even occasional occurrence, Mr. Poland would have had opportunities himself of recording several such facts. The case related by Sir A. Cooper proves nothing in illustration of the theory: the blow could not have been of a severe character; but had it been so, it does not follow that the blow, independent of existing disease, occasioned death.

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* *On Wounds and Injuries of the Abdomen*, prize-essay, by Alfred Poland, Esq.

It is stated that "the sudden impulse made so strong an impression on the heart's action as to stop it, and, without complaining of pain, the man died on the spot." This statement, it appears to the author, should be received with some degree of caution; for it is doubtful whether the poor fellow was seen by any medical man until some time after death; and we would ask whether death may not equally be attributable to disease of the heart, and that the over-exertion of wheeling a barrow too heavy for the physical powers of the man immediately produced that death? Such an exertion would be more likely to excite undue action of the heart, and faintness, than the blow given by the companion. The particulars of the case are by no means satisfactory. Nothing certain can be deduced from the short note relative to the post-mortem examination. We are well aware that in such examinations, in past years, exact pathological conditions were not appreciated as they are now, and that many times deaths were apt to be attributed to accidents or insufficient causes, which in our days are known to depend on actual disease.

In the second case, there is nothing to justify an inference that the blow caused death; and the cause of death, as described by the medical man who saw the case, in no way confirms such inference. Men engaged in pugilistic encounters may possibly die from exhaustion; and death in such instances may more reasonably be attributed to a *series* of blows, and the exhaustion produced by the exertion entailed by fighting, than ascribed to *one* blow unattended by organic lesion.

The last case mentioned by Mr. Poland does not at all bear on this subject. Many bruises were found on the body. Many blows received from any heavy weapon or instrument, by a person in an advanced state of pregnancy, might readily produce such an amount of exhaustion as to be followed by death in a very short period; but neither this case nor the two preceding appear to the author to sufficiently bear on the point, that a blow on the abdomen or epigastrium will produce *sudden* death, without the existence of some severe organic lesion to be found after death.

In Sir A. Cooper's case, the evidence of the amount of violence is unsatisfactory; the minutes of the post-mortem examination are wanting: Sir A. Cooper himself did not see the case; the evidence on his part is second-hand, and would not be admissible in a court of justice, nor should it be admissible in a scientific inquiry.

In the second case, the exhaustion from fighting must be considered to have had a large share in hastening death, and therefore the latter cannot be attributed to one blow: but if so, there is no proof that organic lesion of the abdominal viscera did not exist.

The third case requires no recapitulation; we cannot even class it among the list of *sudden* deaths, as the woman is said to have "died in a short time after" she received the injuries.

With respect to the evidence adduced in favour of sudden death in Mr. Wood's case, we must fairly state, that such evidence is entitled to great consideration; but there are circumstances in this case which should be weighed carefully before a satisfactory conclusion can be arrived at from the report of one solitary example. In the first place, the man had been fighting some minutes; the perspiration on the forehead proved much exertion, this exertion supervening on a state of intoxication: the bruises on the body proved that the man had been "*punished*" previous to the blow on the epigastrium, which, in addition to the exertion of fighting, and the state of intoxication, formed three elements in favour of physical exhaustion. Then the post-mortem examination of the head rather strengthens the supposition that the condition of the pia mater, his previously intoxicated condition, the various blows received in fighting, and the physical exhaustion from the mere exertion of fighting in an inebriated state, with a consequently excited brain, all combined to produce death. The state of the stomach rather indicated the effects of alcohol. In death from alcoholic drinks, Dr. Taylor states that "the brain is found congested, and in some instances there is effusion of blood;"* and it will certainly be admitted that in a state of inebriety, the violent physical exertion entailed by a pugilistic encounter must greatly add to the already congested condition of the brain, and at the same time produce a more rapid exhaustion of the vital powers, than in a condition free from the debilitating effects of spirits.

Still, the author feels it due to Mr. Wood to state, that the case related by him comes near to a fair illustration of the statement and belief, that sudden death is produced by a blow on the epigastrium without evidence of organic lesion; though the author himself is nevertheless somewhat sceptical on the point, that death can occur without any organic mischief resulting from the blow at the time. He has seen nothing to justify any other conclusion. After more than twenty years' experience of vast numbers of accidents admitted into St. George's Hospital, after ample opportunities of examining in the dead-house an immense variety of cases, after reference to all the post-mortem note-books accumulated for many years, and after inquiry among many trustworthy observers, he cannot arrive at any other conclusion; and though he may have erred in this conclusion in the abstract, there can be no doubt that, as a general rule, *sudden* death attributable to blows on the stomach or epigastrium must be a rare occurrence; and that medical men should be extremely guarded in ever offering an opinion as to the cause of death in such supposed injuries, without satisfying themselves, *by most careful and minute investigation*, as to the fact that no violence has been done to the viscera, either abdominal or thoracic.

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* Taylor's *Med. Jurisprudence*, p. 278.

But a very slight blow, without immediate evidence of internal mischief, may be followed by very severe and alarming symptoms. The following case is a well-marked instance of such an occurrence. An old gentleman received a slight blow on the abdomen, accidentally, when turning in bed. He thought but little of the circumstance at the time, but a few days afterwards complained of pain on the right side of the umbilicus, accompanied by tenderness on pressure; with these symptoms commenced a sluggishness of the bowels; a few days subsequently, the pain having increased, a well-marked swelling was detected at the part to which pain was referred; and with this swelling entire stoppage of the bowels was established. In consultation with Dr. Ormerod and Mr. Wildbore of Brighton, the author saw the patient a fortnight after all action from the bowels had ceased. He had been most carefully watched by Mr. Wildbore, who had withheld all solid food, and allowed nothing but fluid nourishment. Leeches had been applied, and constant fomentation to the abdomen. The patient had taken small doses of blue pill, at intervals, for several days. The tongue was moist and rather white; the pulse quiet, skin cool, no vomiting or nausea had occurred. To the right of the umbilicus, there was a distinct deep-seated mass, conveying to the touch the impression of a portion of bowel matted together, and thickened by deposit of fibrine. Gentle pressure could be now borne better than a few days previously, but still produced some pain. On pressing the part alluded to, a sensation was conveyed to the hand as if flatus was moved by the pressure, and was heard apparently passing through a narrowed channel. Beyond these symptoms there did not appear to be any thing really urgent; for although the bowels had not acted for a fortnight, they were not distended; in consequence, no doubt, of the very judicious treatment that had been pursued since symptoms of constipation had set in. Examination of the rectum proved the lower bowel to be empty. It was now decided that the small doses of blue pill taken twice a day should be continued; and that epithems should be constantly applied to the abdomen; and enemata used occasionally. The patient had within the last few days been unable to retain injections. All kinds of solid food to be strictly avoided.

The pain, tenderness, and swelling gradually subsided. A few days subsequently to this visit, the patient was moved to Richmond, and bore the journey without any difficulty.

On the twenty-eighth day of the constipation, he was again seen by the author, in consultation with Mr. Hills of Richmond. The patient was quite cheerful, his tongue clean, appetite good, and pulse quiet. The abdomen was not distended, pain had subsided, and the thickening about the right of the umbilicus had almost entirely disappeared. On examination of the bowel per anum, two or three small portions of fæculent matter were felt. Mr. Hills had observed the day previous that a very small thin portion of fæces, about the thickness of a clay-pipe stem, had come away after the administration of an enema. In consequence of the fæculent masses felt in the rectum, it was decided at once to inject a large quantity of warm water into the bowel. As soon as this had been done, the patient was made to sit on the close-stool, and in a short time afterwards passed some two ounces of fæces, with the water just administered. The latter was now quite tinged with fæculent matter,—the first occasion on which this was observed since the constipation had set in. He expressed intense mental relief at the improved features of his case, and from that day recovery rapidly took place. He is alive now—more than two years since his convalescence.

A boy was admitted into St. George's Hospital late one evening. He complained of great pain over the lower part of the abdomen, but no clear statement of symptoms could be obtained from him. The House Surgeon, concluding that the bladder might not have been emptied, passed a catheter and drew off a small quantity of urine. When seen by the author the following morning, the boy's face was indicative of suffering; the brow contracted, the pulse quick and sharp. The muscles of the abdomen were resistent and tense to the touch; slight pressure produced considerable pain over the lower portion of the abdomen, especially towards the right side. There was evidently peritoneal inflammation, from some cause. After some questioning, the lad confessed to having been kicked on the abdomen by a boy, while at play, the afternoon previous to admission, and that much pain was experienced after the kick. The lad was averse to mention the circumstance when he got home, but the pain became so severe the following day, that he was kept at home by his parents, and lastly brought to the hospital. Leeches were applied to the abdomen, followed by constant fomentations, and he was ordered small doses of calomel and chalk every four hours. The next day the pain was less, but the pulse quick, and tongue white and rather dry. The leeches were repeated, and the calomel continued. He steadily improved under treatment, and in a few days was convalescent. He soon left the hospital, recovered.

These cases of injuries to the abdomen followed by inflammatory peritoneal action are satisfactory instances of favourable termination.

The following case illustrates the more severe effects of peritonitis after an injury. A woman was admitted into St. George's Hospital in 1859, under the care of Mr. Johnson. She had been kicked on the abdomen by her husband, on the lower part of the left side. The kick was followed by excessive pain and general peritonitis. There was great and constant difficulty in procuring action of the bowels. The symptoms were treated by the application of leeches, fomentations, and the internal administration of mercury; but the tenderness and distension of the abdomen, constipation, and difficulty in passing motions, continued for some six months. The patient was greatly reduced, and when she left the hospital there was much distension of the abdomen, general pain on pressure, and an inability to move about with any degree of activity. The diagnosis was, that the bowels had become matted together to a great extent by adhesion of their peritoneal surface.

These cases prove that we may have to contend with severe symptoms produced by a comparatively trifling injury, and that we may find but slight ultimate mischief remaining subsequent to most alarming conditions.

Additional cases might be produced to illustrate these observations, but the relation of a greater number would not more clearly explain the practical results of such injuries; suffice it to say, that the slightest blow on the soft walls of the abdomen must always be considered with care, and treated with due caution; but that we must not look with despair on what may at first appear, from the severity of the symptoms, a most formidable injury.

Let us inquire what are the pathological conditions and consequences of a blow or other injury on the abdomen. External to the peritonæum, we may find—

1. Rupture of muscle.
2. Contusion of the soft tissues, with extravasation of blood.
3. Without the former, and without external wound, rupture of the peritonæum, and consequent extravasation of blood into the cavity of the abdomen.

1. Rupture of muscle is not often detected as a result of external violence to the abdominal wall, unless the accident prove fatal. Any direct blow may rupture the fibres of a muscle, without producing other injury; and the abdominal muscles are not exempt from this liability. The author was consulted by a gentleman suffering from an apparent rupture of the inner fibres of the recti muscles, about midway between the umbilicus and pubes. The injury was the result of a book falling directly on the abdomen, one corner striking the part affected. There were no severe symptoms immediately subsequent to the blow, but, after recovering from the first bruise, there remained an inability to perform many of the movements of the body, especially those in which the actions of the abdominal recti muscles are much called into play. In the recumbent posture on the back, the patient was unable to raise himself, nor could he do so without turning on one side—and with care only could he move; walking to any extent was followed by discomfort, and even pain in the region injured. The local conditions presented an evident separation, or want of muscular fibres, to the extent of about one inch and a half in diameter. The patient had suffered general inconvenience in movement, rather than any constitutional disturbance; and at the termination of twelve months after the injury, appeared little better able to take active exercise than he could a few weeks after the blow. It was not considered advisable to recommend more than caution in exercise, and a support to the abdomen, so as to restrict extension of the body, either sudden or beyond the upright position.

As the result of tetanic spasm, we have witnessed rupture of the broad muscles of the abdominal wall.

Mr. Poland, Surgeon to Guy's Hospital, has favoured the author with notes of two cases, in persons of advanced life, in both of which rupture of the rectus took place from the patients' falling against their iron bedsteads in the wards of the hospital. In each instance, the patient had been suffering from severe illness; one from the effects of fever, the other from disease of the urinary organs, and both were at the time greatly reduced in strength.

Lagouest reports a case of a soldier, aged 27, who, while performing some gymnastic exercises, was attacked with severe pain in the abdomen, which increasing and being accompanied by swelling, he was taken to the Val de Grâce. A little above the pubes, a hard, well-defined tumour was observed, not increased by coughing, and which followed the course of the right rectus, increasing in breadth towards the umbilicus. At the termination of a week, only slight hardness remained. The case terminated favourably, with rest, regimen, and cold applications.*

The symptoms of ruptured rectus muscle may be judged of from the foregoing cases: pain, sudden in character, most probably attended with swelling from effused blood, and probably indicated by a dent in, or by a marked separation of, the torn ends of the muscle; pain, increased on motion, even to such an extent that movements of the body may be almost impossible for a time.

The treatment of rupture of any abdominal muscle, when such is suspected to exist, must chiefly consist in rest, and attention to position, so as to relax the injured muscle. The results are generally far from satisfactory, after the patient has recovered from the immediate effects of the accident; in all probability much weakness will be experienced in movements, at the injured part; and pain will most frequently persist, as a lasting evidence of permanently damaged tissue.

Another evil is very apt to follow upon the rupture of an abdominal muscle, however slight the injury may be, viz. that a hernia may present itself at the point of separation of the muscular fibres; and in most cases such a consequence may be anticipated. The coverings of such a hernia would be devoid of muscular fibres, and the contents would be little liable to strangulation, from the fact that the sac is devoid of a constricted neck. A large pad, with a bandage or truss, will be necessary in such cases for life.

We have not been able to satisfy ourselves that there is any foundation for a suggestion of Virchow, viz. that abscesses of the abdominal wall are frequently dependent for their cause on ruptured muscle.

Contusion of the external soft parts of the abdomen, with extravasation of blood into the cellular tissue, may be extensive; and will generally be indicated, more particularly a few days after the injury, by the usual ugly-looking patches under the skin, of blackish-red colour, which subsequently shades off into blue and green, and roughly marks out the extent to which blood has percolated into the surrounding structures. Associated generally with such extravasations, will be indications of bruised muscle to some extent; the patient will complain of pain in movements; or even while resting quietly in bed, will experience a soreness, or discomfort in respiration. There need not be much cause for apprehension under such circumstances, provided no indications be present of *peritoneal* injury.

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* *Gazette des Hôpitaux*, 1860, no. 76.

When secondary inconveniences arise in cases of contusion of the soft tissues, they occur mostly in those instances in which *large* quantities of blood have been extravasated. Blood does not *then* become readily absorbed; and suppuration and abscesses may be the result. The former will often become extensive, or the latter may form very large cavities; and either may be very tedious in its process towards reparation. The progress, however, will be slow or rapid, for good or for evil, according to the state of the patient's health. In an unhealthy condition of body, suppurative inflammation will generally be attended by much constitutional suffering; the integuments become inflamed, and often slough; or matter burrows in various directions, and requires constant watching, and early and ample exit: all which may, sooner or later, terminate in the patient's death, without having produced visceral complication.

The *quantity* of the blood extravasated, quite as much as the direct *injury* to the soft parts, must weigh in the balance which determines the formation of an adverse or favourable opinion regarding the patient's future. Given the amount of the extravasation, we may almost foretel the progress of the case.

But a direct bruise may be followed by a slough of the tissues. This result, as a general rule, is not a common feature in such an injury to the abdominal walls. Usually, the apparent mischief to these soft parts is rather less than serious. Their peculiar attachments, position, and relations render them capable of receiving pretty considerable pressure, without offering resistance, and they may thus yield to or avoid the effects of compression, which would otherwise be sufficient to destroy their vitality at once, or materially interfere with it subsequently.

It is not common to witness extensive or serious contusion alone of the muscles and external soft tissues of the abdomen, short of more serious complications of some of the viscera. So that our attention need not at present be directed to such contingencies, as the lesser evil would succumb, both in symptoms and in treatment, to the greater.

The treatment of bruises with extravasated blood in the walls of the abdomen is very simple, and should be similar in all essentials to the treatment of severe bruises of other portions of the trunk or limbs. The Surgeon should ascertain, without delay, that the patient can pass water readily, and that there be no tinge of blood in the urine. The presence of blood generally indicates deep-seated extravasation and visceral injury.

Rest should be enforced in the recumbent posture, or, if the bruise be very severe, or the extravasation extensive, strict confinement to bed should be enjoined; fomentations should be applied constantly to the part, to relieve pain, and to soothe the stiffness and discomfort of the bruised integuments; the diet should be regulated according to the patient's powers and constitutional state.

In extravasations of blood from contusion of the parietes, our watchfulness should be constant whenever the extravasation is so great in amount and of such an extent, as to occasion a prospect of suppuration. The circumstance of suppuration following upon such extravasations will be indicated at first by some, more or less, constitutional disturbance: slight blush commencing on the surface of the skin over the injured part; the swelling increasing in extent; the inflamed skin becoming shiny and tender to the touch. Should such evidences of commencing suppuration manifest themselves, the fomentations should be changed for poultices or lint and warm water under oiled silk. As the local mischief increases, the constitutional disturbance becomes aggravated; and unless the symptoms are relieved by the exit of the matter collected, they may become very alarming in character. The earliest opportunity to give escape to matter must be sought by the Surgeon. A free incision, under circumstances indicated by the above severe symptoms, is soon followed by considerable local relief, and by a marked amelioration in the condition of the patient.

And now the treatment should be conducted on the same principles as in similar injuries of other parts. Especial care should be taken to prevent matter burrowing deeply, for the want of ready external outlets; and any reluctance in the wounds to heal should be suspiciously watched, and care taken that if any sinuses exist or ensue, they be laid open to the extreme extent of practicability and safety.

Abscess, the result of extravasated blood, following contusion of the abdomen, may prove a serious as well as a tedious matter, when pus collects and burrows in and about the region of the pelvis: nor can the Surgeon be too circumspect or too energetic in his efforts to give an early and ample vent to purulent fluid, whenever a suspicion crosses his mind that matter is lodged any where in the neighbourhood of the original injury, and within reach of the knife. Months of suffering may result from any want of early care or prompt determination in the treatment of such a case; and it is no uncommon result, that a patient sinks after a long period of pain and suppuration, exhausted by the profuse drain on the system caused by the secretion of numerous and tortuous sinuses.

When suppuration has once commenced, and a free outlet is established, the patient should be supported by generous diet and a liberal allowance of stimulus. Frequently the drain on the system, when such accidents give rise to suppuration, is so considerable in amount that very large quantities of stimulating fluids may not only be taken with impunity, but are essential to the maintenance of life during recovery.

Our next point for consideration is, the probability and the effects of rupture of the parietal peritonæum, from a blow or external violence, without injury to the abdominal viscera. The question which may naturally be asked, is, whether such an injury can occur without the complication of visceral mischief?

Experience answers, that it is just possible occasionally; but that in the majority of accidents, in which violence is applied to any portion of the abdominal region, such a result is the exception to the rule. In most instances, the symptoms which present themselves barely justify a certain diagnosis, and in very few instances a difference in treatment from that necessary for injured viscera. That the peritonæum will not yield to sudden stretching as readily as some of the tissues which lie subjacent to it, is well illustrated by the fact, that rupture of the peritoneal covering of the uterus has taken place, while that viscus has remained entire: also, by the fact often observed in cases of enormous and rapid distension of the large gut, when it has been suddenly blocked by a twist, a tumour, or other mechanical obstruction, in which instances we have frequently found rents in the peritoneal coat alone, without corresponding rupture of the remaining coats of the bowel.

The following interesting case would rather fall into the category of rupture of the peritonæum, with subsequent and severe hæmorrhage. The author is indebted to his friend Sir. R. Martin for the particulars. Two men were run away with in a gig, and one of them—healthy, and about 25 years of age—was thrown out with great violence, and fell from a height of many feet on a quarter-staff, which he had retained in his grasp,—the one end of the staff having become fixed in the ground, while the other received the falling man upon his epigastric region. It was represented that the man was at once rendered insensible, and remained so for about an hour; soon after which he was seen in bed by Sir R. Martin. "The countenance and general appearance had all the characters of the most fatal collapse of remittent fever, with the addition of urgent terror. There was the concentrated epigastric anguish, and the body was fixed and immovable; the abdomen being enormously tumid and hard as a barrel, the epigastric region intolerant of the weight even of the sheet. The pulse was not to be counted, and the skin was cold and damp. I considered the symptoms referable to both epigastric shock and hæmorrhage. The man was ordered diffusible stimuli, with small doses of calomel and opium, which were continued until the system was brought gently under mercurial influence. The patient recovered steadily and without accident." Sir R. Martin's remarks at the conclusion of the case are worthy of notice: "We can but conjecture," he says, "at the nature and extent of the injury in this case. My own view at the time was, that rupture of the peritonæum, with hæmorrhage, had occurred; certainly, I have seen men killed by blows, on the abdomen, of less violence than took place here. The anguish of both mind and body was greater than I remember ever to have seen, either in the collapse of remittent fever, or from wounds or accidents.

"A young officer of dragoons, who was shot in a duel, the ball passing right through the liver and spleen, suffered much anguish during two-and-thirty hours that he lived; but his sufferings were nothing as compared to those in the case above described. Indeed, I have never witnessed any thing like them in severity, the patient recovering from the injury."

It may, however, be objected that rupture of the peritonæum by sudden force can rarely, very rarely, occur without some laceration of the part which the injured membrane covered. And this is no doubt the fact in very many instances; but as the consideration of ruptured viscera will form a subsequent portion of this essay, the complications of visceral injury will not now be entered upon, in connexion with simple rupture of the peritonæum.

In the museum of St. George's Hospital is a preparation* in which may be seen a laceration of the peritonæum covering the mesentery, the latter also being implicated in the laceration to the extent of about an inch; there were also to be seen several small accumulations of extravasated blood around the lacerated part. The injury occurred in a man who was kicked on an inguinal hernia; the protruded intestine was also ruptured at a point distant from the lacerated peritonæum and mesentery.

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* Series 33, sub-series 1, preparation 1.

Our diagnosis of the injuries already considered will depend on symptoms which, in some cases, will be immediate upon the injuries; and in others will not be evident until some time has elapsed. A blow upon the abdomen, though followed by much faintness, need not be necessarily otherwise than harmless in its effects; and it may be pronounced to be harmless, if the faintness be not lasting, nor followed by vomiting, or pain, or great anxiety, with disinclination to movement.

Provided there be no visceral complication in any instance of rupture of the parietal or visceral layers of the peritonæum, the *first* and *chief* danger to be apprehended from such an injury is hæmorrhage. If the rupture of the peritonæum be confined to any portion attached to the abdominal wall or diaphragm, the *probability* is, that there will not be hæmorrhage to any alarming extent. But if the rent occur in a portion attached to a pregnant uterus, to the omentum, or to the mesentery, the probability is, that hæmorrhage will be excessive, and it may prove fatal. Under these circumstances, there will be general blanching of the surface of the body, anxiety of countenance, constant yawning, sensations of great distress and sinking, rapid pulse, and great restlessness in bed. In this latter respect there is a most marked difference in a patient suffering from ruptured viscera. He lies in a constrained, quiet posture, usually on his back; the muscles of his abdomen are tensely contracted. The patient with ruptured intestine complains of severe continued pain, always accompanied by vomiting, which is persistent and constant, and which nothing relieves; but with rupture of the peritonæum alone, followed by excessive hæmorrhage, whatever the amount of pain, vomiting may and will generally be entirely absent; and in the absence of pain, the patient's anxiety is solely referred to the extreme collapse, and he often expresses himself to be dying.

The course of such a case is run more rapidly than that of one with ruptured intestine without hæmorrhage. A few hours may terminate life, before any secondary action has had time to commence. It is the extent of extravasation, rather than the extent of laceration, which settles the rapidity of the case;—it is *that* alone, we may almost say, if the viscera be not ruptured, which calls for our utmost care, and aggravates our anxiety. Short of hæmorrhage, and short of ruptured intestine, a laceration of the peritonæum *need* not alone be fatal—probably *will* not be fatal. The conditions generally found after death, when hæmorrhage has been the fatal cause, are either rupture of the mesenteric vessels, or of the vena cava, or other large veins or arteries. The rupture of the larger vessels seldom is the result of a blow, but rather that of heavy weights passing over the body. The portal vein has been found ruptured previous to entering the transverse fissure of the liver, and without laceration of this viscus.

In the treatment of such injuries, no general law can be laid down, no canon can dictate our practice. Passing over those cases in which excessive hæmorrhage rapidly destroys life, and which admit of no beneficial or mitigatory treatment, let us look at such as may require the Surgeon's care, and may be successfully managed. The cases which will demand, and will repay, the most careful watching—perhaps much active and assiduous attention—are those in which the injury is followed by peritonitis, either of a chronic or of an acute character. Such cases must be constantly, frequently, and most carefully watched during the early days after the accident; for it may well be laid down as a maxim, the truth of which we have already illustrated, that the most trifling blow on the abdomen may be followed by symptoms sufficiently serious and alarming, and require our utmost skill and attention.

In most cases, should symptoms of peritonitis supervene, we may safely resort to the free application of leeches to the abdomen, over the part chiefly in pain; and these should be followed by large and hot fomentations of moist flannels, or flannel-bags of bran or camomile wrung out of hot water, or large linseed-meal and bran poultices. Sometimes the relief to pain and the personal and local comfort afforded by leeches and subsequent warm applications, is most marked in these cases, and often highly satisfactory to the patient and beneficial in treatment. Opium, under the circumstances of peritonitis supervening, is the sheet-anchor of the vessel riding in a gale of wind. Opium should be given freely, fully, and frequently. The index to its limit is the effect on the system. We should only allow it to be diminished or withdrawn when narcotism is indicated by the manner of the patient, or the effect observed on the irides, or an abatement marked in the severity of the local symptoms, for the relief of which it was ordered. Calomel, in our opinion, should also be combined with opium, in these peritoneal affections, though only in small doses often repeated. It should be withheld on the first evidence of its specific action on the mouth and tongue.

Purgation should be avoided as a provocative of inflammation in these, as in all inflammatory affections within the region of the abdomen resulting from injury. If rest be desirable to the broken limb, equally is quiescence necessary to the recovery of the patient with lacerated tissues within the cavity of the abdomen; and any purgative may be looked upon as a poison in such instances. To allow an inflamed eye or any injured organ to recover, we advocate rest, that Nature may exercise her share, not a small one, in the restoration of each to health. It is the well-judging Surgeon who, taking a hint from Nature's teaching, leaves to rest and quietness that which by active treatment might have been seriously injured. And yet how often we have seen purgatives of an irritating character recklessly advocated in the early stages of such cases; a treatment which cannot be too strongly condemned, and a practice which only appears adapted to accelerate a fatal termination. If constipation supervenes, the mercurial treatment should be steadily persevered in, short of salivation to the slightest degree; and trust should be placed in the natural action of the intestine, subsequent to the reduction of inflammation, rather than in any efforts made to hasten the action by other aids, with the expectation that purgatives can lessen the local mischief.

Rupture of the diaphragm is not a very common injury, and when it does occur is usually the result of much external violence. In such a case, it generally happens that some serious visceral mischief is associated with the laceration of the muscle. But a rupture of the diaphragm may take place without lesion of the adjacent viscera; and in such an instance hæmorrhage will in all probability be small in quantity.

A wound of the diaphragm may readily occur; the muscle is often transfixed by a knife, or bayonet, or other sharp-pointed weapon thrust into the lower portion of the thorax, or through the upper portion of the abdominal wall. A wound of this muscle produced by a penetrating instrument will, most probably, be complicated with wounds of some of the adjacent viscera; and in such a case hæmorrhage will generally be rather severe.

A rupture or wound of the diaphragm, if not complicated with visceral injury, and if not considerable in extent, is by no means necessarily, of itself, immediately or ultimately fatal. Even with a large laceration of this muscle a person may live for some months.

The case recorded at page 420 is a well-marked instance of a severe laceration of the diaphragm: in this case the patient survived eleven weeks, although the laceration was complicated with rupture of the spleen.

There is no limitation to the part of the diaphragm which may be the seat of a *wound*, but in the greater number of cases of *laceration* it has been observed that the injury has been confined to the left side. Devergie has confirmed this observation, which is supported by the case on p. 420, and by the following instances:

Thomas A., æt. 20, was admitted into St. Mary's Hospital, "suffering from pneumo-thorax and diaphragmatic hernia," of which he died about thirty-two hours after admission. "The opening in the diaphragm was in the left portion of the tendon, near its posterior part, and was large enough to admit the hand." *

E. L., æt. 40, was admitted into Guy's Hospital, having fallen from a great height on to the deck of a vessel. He died about three months after the accident. An opening was discovered in the diaphragm a little to the left of the œsophageal opening, about two and a half inches in extent. †

The symptoms of laceration of the diaphragm, we may conclude, will be generally of an obscure character; and it will very much depend upon the manner in which the accident occurred, whether sufficient symptoms will be referred directly to the seat of injury to enable the Surgeon to arrive at a correct diagnosis. If the rupture be the result of a fall from a height, or of a heavy weight having passed over the abdomen, there will be so much general bruising, or visceral laceration, that any symptoms of rupture of the diaphragm will escape detection in the more severe and urgent condition of the patient. But the muscle may be ruptured by sudden spasm or action caused by a slight fall or slip. The patient would, under such circumstances, be cognisant of an instantaneous snap or darting sensation in the part, followed by intense pain. There would also be more or less difficulty in walking; inability to use much muscular power; and most probably some disturbance or difficulty in the respiratory movements.

Thomas A. (the case already quoted) "slipped while walking in his own house; and in trying to save himself from falling, gave himself a severe twist, when he felt something snap at the lower ribs on the left side, followed by great pain, to such an extent that he could hardly breathe for some minutes."

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* *British Medical Journal*, 1858, p. 922.

† Poland's *Prize-Essay*, p. 330; also *Guy's Hospital Reports*, 1838, p. 366.

A laceration or wound of the diaphragm *per se* is not necessarily fatal. But the aperture in the muscular septum is generally productive, sooner or later, of serious results. These serious consequences arise from the escape of some of the contents of the abdomen, through the laceration, into the cavity of the thorax; such a protrusion constituting that variety of hernia termed phrenic or diaphragmatic. "A uniform effect of these ruptures when extensive," writes Dr. Alfred Taylor, "is a protrusion of the stomach into the chest, with sometimes a rupture of the coats of that organ, and extravasation of its contents."* But portions of the small intestine, transverse colon, omentum, and spleen have been found in the cavity of the pleura subsequent to an extensive laceration of the muscle.

The symptoms of such protrusion into the cavity of either pleura would be generally well marked. The side of the chest implicated will be somewhat prominent, and the heart will, to a corresponding extent, be pushed over in the opposite direction. On percussion the sounds may vary. If the protrusion be stomach or intestine distended with air, the resonance will be most evident; but should solid viscera have passed through the laceration, the sounds will, to a corresponding extent, be dull. No respiratory sounds will be heard, under either condition, over the part in which lie the escaped viscera. Constant vomiting will also be generally present. With the escape of portions of the viscera into the cavity of the chest, obstruction to the passage of their contents usually occurs, and the patient's life is soon sacrificed. Or death may follow an attack of pleuritis set up either immediately by the rupture, or subsequently produced by the irritation of the foreign viscera in the cavity of the thorax.

We are silent on the subject of treatment in this accident. As long as the opening in the diaphragm exists, there is the prospect of protrusion of viscera through it, and consequent obstruction. We cannot hope to close the aperture by any measures which science or mechanical surgery would justify; and therefore, could we most accurately detect the existence of a protrusion of viscera through the aperture, it were vain to attempt its reduction with any prospect of benefit to the patient or credit to ourselves.

Contusion of the parietes of the abdomen, complicated with rupture of viscera, is a subject replete with interest, and an injury more formidable in its character, and more fatal in its results, than most of those alluded to in this essay.

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* *Medical Jurisprudence*, p. 392.

In their respective order, we must consider individually rupture of the food-tube and its accessories: viz. (1) the stomach and intestines, (2) the liver and the spleen.

As the result of accidental violence, rupture of the stomach in a state of health is a very rare occurrence. In its results, as a rule, it may be considered as surely fatal. Rupture of the *stomach*, or rather perforation, the result of ulcer, is not an uncommon lesion; but is one rapidly fatal, and consequent on a long-standing and troublesome affection. Such an occurrence is characterised by sudden, sometimes excessive, pain, great depression and intense anxiety, rapid pulse, and every indication of immediately approaching death. A few hours suffice to terminate the sufferings of the unfortunate victim of this disease. It would be useless, were it our province, to offer any remarks on the treatment of such a case.

The blow or compression which would in a state of repletion be sufficient to produce a large rent in the stomach, would occasion but a very small opening if little food were contained in it; but however small in quantity this might be, the escape of the smallest portion into the peritoneal sac would be sufficient to originate violent inflammation, and that of a rapidly fatal character.

Under any circumstances, can we entertain a hope that rupture of the stomach may not prove rapidly fatal? It is just possible. If the laceration of the coats were confined to those portions which are attached to the omentum, above or below, extravasation of the contents might be limited in quantity, and confined to parts external to the cavity of the peritonæum; though such a condition would probably be but a temporary stay to future mischief; for the extravasation would sooner or later terminate in suppuration, and the secondary mischief set up prove equally fatal, as a rule, as when it follows at once upon the escape of the stomach-contents into the cavity of the peritonæum. It is probable that the following case may bear the above explanation. A woman received an injury on the abdomen, followed by an indolent swelling over the left part of the epigastrium,—which swelling, suppurating, and ulcerating externally, formed a fistulous communication with the cavity of the stomach. The woman lived some months after the formation of the fistula. On the examination after death, the opening in the stomach was found towards the pyloric extremity, and was intimately adherent to the abdominal parietes.*

In the first Number of the *London Medical Review*, July 1860, is recorded a case of rupture of the stomach, in a man aged twenty-four, who fell from a ladder on to some iron railings. He died about eight hours after the accident. When admitted into the Middlesex Hospital, under the care of Mr. Moore, the patient was perfectly sensible, but in a state of great prostration—pulse very small and feeble. Brandy was administered. This he took with great reluctance, and at his earnest request it was not persisted in. He stated that it increased his sufferings.

Post-mortem examination. "The cavity of the peritonæum contained about twenty-six ounces of fluid, resembling coffee-grounds. On the anterior aspect of the stomach, just below and to the left of the pylorus, was an abrasion of the peritoneal coat two inches in length. Immediately beneath the pylorus, the anterior wall of the stomach was completely ruptured, in a horizontal direction, for the space of three inches. The mucous membrane of the stomach, just above and just below the rupture, presented two clean cuts, exposing the submucous tissue, which was intensely injected. The upper of these cuts measured three inches, the lower one, an inch and a half." Most of the ribs on the left side were fractured, and there was rupture of the spleen. "There was a superficial abrasion of the liver, an inch long, on its inferior surface. Close to the internal abdominal ring, on the right side, was a rupture of the peritonæum, large enough to admit the thumb. There were also numerous abrasions of the peritoneal coat of the transverse colon."

Perforation of the *intestine*, that is, rupture of the intestinal coats, the result of external violence, without any external wound, is by far the most frequently formidable injury of the abdominal viscera with which the Surgeon has to contend in practice. From the commencement of the duodenum to the termination of the sigmoid flexure of the colon, in any part of the whole length of the intestine, rupture of the entire wall does constantly occur from violent, sudden, or passive forces applied to the front or sides of the abdomen. We propose to consider the various forces which produce such accidents, and the various situations in which the injury may occur.

Rupture of intestine is a very common result of a kick from a horse; in very many cases with rupture of the bowel admitted into St. George's Hospital, the injury could be attributed to this cause. In such cases, the aperture in the bowel is generally small; whereas more extensive lacerations are found when the injury has been caused by heavy weights passing over the body. In the latter instances, the intestine may almost be severed transversely. Every variety, from a small pin-hole perforation to an entire transverse division of the walls of intestine, may occur from a variety of forces acting on the abdominal walls; but into these points it is not necessary to enter more minutely. It may fairly be asked, whether a rupture of the intestine is to be considered a fatal accident? It can, we fear, rarely happen that recovery should take place, if the lesion be sufficient to permit the escape of fæcal matter into the peritoneal cavity, and the rupture be not accompanied by an external wound. The effects of such a lesion are so formidable, that we may certainly, as a rule, pronounce all such cases to be utterly beyond the boundaries of relief and recovery.

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* Richerand, *Physiol.* tom. i. p. 282.

A man was admitted into St. George's Hospital in December 1841, having been rolled upon by a horse that fell with him. The patient complained of severe pain across the abdomen; countenance very pale; pulse very weak; not much tenderness on pressure; vomiting soon commenced after admission. The following day all the symptoms were aggravated; the pulse became very quick and small; countenance very anxious. He died thirty-four hours after admission. There were general adhesions of the peritonæum to the great omentum, and also of the convolutions of intestine to each other; the lymph being of dark grumous colour. The cavity of the peritonæum contained a large quantity of bloody fluid, quite free from fæcal taint. About the middle third of the jejunum, the bowel was formed into a kind of loop from adhesion to the transverse colon, and presented a very dark and congested condition; on separating the adhesions, a small rupture of the jejunum was seen; escape of the contents of the bowel had been prevented by firm adhesions, and also by a large coagulum formed in the immediate situation of, and fairly surrounding the rupture. Some portions of the intestine presented a dark appearance, as if bruised.

Such a case as the above marks the possibility of rupture of intestine without escape of fæcal matter. This patient probably died as much from the effects of inflammation, set up by the bruised intestine, as from the effects of the rupture. The post-mortem appearances in this instance are a fair index of the pathological conditions generally found after similar injuries.

The immediate effects of such a lesion as rupture of bowel from external violence are most characteristic. The pain following the blow is rapidly merged into that which is often excessive, and is apparently the result of the escape of fæculent fluid into the peritoneal sac. Pain is much increased by pressure, and sometimes to such an extent that the patient cannot bear the weight of the bed-clothes. The anterior abdominal muscles become rigid and unyielding to the touch; tense, hard, and resistant to any examination by the hand; and almost convey the sensation of a board, rather than that of animal tissue, laid over the surface of the bowels. The countenance rapidly assumes the most anxious and restless aspect; vomiting sets in early, and is more or less constant and distressing to the end; the fluid vomited being at first the remains of the last undigested meal, and then porraceous, and latterly dark-coloured, slightly tainted by fæculent smell. The tongue varies in appearance, but generally is coated and dry, and red at its edges; great thirst is often a marked symptom. A symptom spoken of as a sure indication of ruptured bowel, is early and excessive collapse; but collapse, though generally present to a great extent, will sometimes be wanting to such a degree, that if, as a symptom, it be much depended on, an incorrect conclusion might be arrived at respecting the extent of the injury.

The coachman of my friend and colleague Dr. Fuller was kicked on the abdomen by a horse, early in the morning. The man experienced great pain immediately after the accident, but was able to walk some little distance from the stable to his lodgings, and then upstairs to his bedroom, without any indication of collapse. When I saw him with Dr. Fuller, about an hour after the accident, there was no collapse, and the pulse gave very little indication of serious mischief; but the pain, the tense state of the abdominal muscles, the anxiety of countenance, and the vomiting then present, pretty surely indicated rupture of the gut. The post-mortem examination displayed a lacerated opening in the small intestine.

It may appear superfluous to speak of treatment, when we start with the conviction that rupture of bowel is necessarily fatal. But in these serious injuries, if treatment is to be of avail, it certainly appears absolutely necessary that all our efforts should be directed to the maintenance of rest in the injured part. It will be found that vomiting and costiveness are the invariable accompanying conditions of ruptured intestine. Nature's indication, as well as Nature's effort, appear to be, to avoid all disturbance, and preserve strict rest of the injured part, by emptying the tube above, and arresting its action below; and the lesson she teaches us we should be ready to appreciate and enforce. Opium administered internally from the first, is one great indication, marked by her teaching. We learn the advantages of opium administered in instances of bruised or inflamed intestine reduced after strangulated hernia; equally important, if not more so, is the action of this drug in cases of ruptured bowel. The dose is only to be suspended when narcotic effects are evident, but otherwise should be repeated and increased until some beneficial or specific action is observed. Leeches to the abdomen, fomentations, sinapism, and turpentine on flannel, should be applied much in the order stated; and the leeches repeated, if requisite to relieve pain, &c. In such cases depletion cannot be had recourse to often, or carried very far with benefit. The pulse soon begins to fail. It must ever be borne in mind with respect to treatment, that the inflammatory action is the result of local extravasation, and not of idiopathic or constitutional causes, and therefore less under the influence of general measures. It is a question how far mercury should be administered in these injuries. I believe it to be occasionally a beneficial, and therefore justifiable, therapeutic agent, but only in combination with opium; and with opium it should be administered in the early stages of the symptoms, in small and oft-repeated doses. One grain of each drug may be given every three or four hours. The repeated doses of opium will often be borne for many hours, and the patient in no way injuriously affected by it.

A few hours to three or four days will be the extremes of time that a patient may survive after the occurrence of a rupture of the bowel. Upon examination after death, marked evidences of the escape of the contents will be present: general peritonitis, the edges of the convolutions being glued together; discoloured and purulent fluid confined between the folds of the intestine, and especially in the lower portion of the peritoneal cavity. According to the size of the rupture, so in a great measure will be the amount of effusion, as also the rapidity of the termination of the case; for the symptoms will be more acute, and the progress more rapid, the larger the escape of fæculent fluid. The wound in the intestine will often be hidden by adhesions, and care is sometimes required to ascertain its situation. It will probably have early become adherent to the adjacent surface of bowel, or omentum, or any neighbouring viscus, and, as a consequence, before the period of death escape of the contents of the gut will have ceased. The edges of the wound are always found everted, and the mucous coat projecting, plugging up the aperture when not of a very considerable size.

In an injury such as we have now considered, what prospect has a patient of recovery?

It would be mere conjecture to suppose a case of recovery probable after escape of fæcal fluid into the peritoneal sac. It only appears possible that a patient should even survive for a time, *i. e.* beyond a few days, if the rupture were situated at the attached margin of the bowel, and the escaped fæculent fluid were confined between the layers of the mesentery. In such an exceptional case we must expect subsequent serious mischief. Abscess and chronic peritonitis, and more or less adhesion of the surfaces of the intestines and viscera, would be the chief features of the case; matter might approach the surface, and be detected in time for evacuation, before discharging into the peritoneal cavity. Such a case would be long in recovering, and would call forth all the attention and skill that the experienced practitioner could bestow upon it. An early exit for the pus would be most important, and great care should be taken to prevent burrowing sinuses, and confinement of matter.

Lacerations of the substance of the *liver* will be frequently met with in post-mortem examinations of persons whose deaths have been occasioned by injuries to the abdomen; but though such lacerations are not uncommon results of accidents, the termination need not necessarily be fatal.

If the laceration be not extensive,—if it be limited to the surface of the liver, merely a slight superficial crack,—the patient may recover without much suffering, and without any particularly marked indication of the existence of the injury. If the laceration be at all extensive or deep, the patient soon dies from the effects of hæmorrhage into the peritoneal cavity. Post-mortem examinations bring before us every condition of rupture, from the slightest rent running through the peritoneal covering, and barely tearing more than the most superficial surface of the liver, to the most complete smashing up of the organ. Only in the slighter injuries can we anticipate a favourable result. Death rapidly steps in, and appropriates the more serious.

A man, æt. 33, was admitted into St. George's Hospital, Nov. 25, 1847, under the care of Mr. Cutler. The patient was blanched, and in a cold sweat. He had been shortly before kicked on the epigastrium by a horse. The man was in great pain, and excessively faint, and became rapidly more exhausted. He died an hour and a half after admission. There were marks of recent ecchymosis over the epigastrium, and in the substance of the muscles, especially of the left side. The cavity of the peritonæum contained much fluid blood. There was a very extensive laceration of the liver, nearly separating it into two portions, these being held together by nerves, vessels, and some shreds of bruised liver-tissue. There were also some lacerated spots on the posterior surface of the left lobe. The other viscera were healthy.

Rupture of the liver may occur without rupture of the peritoneal coat, and without hæmorrhage into the peritoneal cavity. A man, æt. 25, was admitted into St. George's Hospital, May 26, 1847. He was pale, cold, and gasping for breath. He died in two hours. The wheel of a heavily-laden cart had passed over him. The peritonæum covering the upper surface of the liver appeared slightly bruised. On cutting into the upper part of the right lobe, considerable laceration of the substance was found, though the peritonæum was entire.

In this instance there was also extensive laceration of one lung, and fracture of several ribs; but, irrespective of such complications, the injury to the liver might fairly be considered as one favourable to recovery;—an instance of laceration of the liver unattended with hæmorrhage into the peritoneal cavity.

We cannot mention any definite symptom by which, during life, a rupture of the liver may be unmistakably detected. If the rupture be slight, there is but little beyond the usual symptoms attendant upon an injury of the abdomen, not of a severe character. Greater tenderness may be experienced over the region of the liver than elsewhere; but such a symptom cannot be assumed to be positively demonstrative of laceration; for, on the one hand, the tenderness may exist after a direct blow without rupture, or, on the other hand, the liver may be lacerated from violent concussion of the organ, and there be no marked or defined local pain.

When the laceration is extensive, it may be suspected more surely than when slight, from the rapid collapse of the patient: loss of pulse, extreme faintness, pallor, and great distension of the abdomen,—all indicative of excessive internal hæmorrhage.

Injuries of the abdomen productive of laceration of the liver, and attended by such hæmorrhage, are perhaps the most rapidly fatal of all: and patients will expire in periods shorter or longer, proportionate to the amount of the bleeding.

It would be useless to talk of treatment in such cases. Death steps in and removes the patient from suffering, often ere the question of restorative treatment can barely be entertained. But in minor lacerations every precaution requisite in the treatment of other injuries of the abdomen must be strictly observed. Absolute rest is one most essential condition to be insisted on. *The patient should not even be allowed to raise himself or be raised in bed*, if it be suspected that much blood has escaped into the cavity of the peritonæum or elsewhere. For under such circumstances, though the patient may appear to be going on well, death may occur with the slightest exertion. If pain supervene, and the pulse indicate increased action, leeches may be applied with caution. But opium should be administered, alone, to quiet the nervous system, or combined with calomel in small doses, should peritonitis be evidently commencing. Fomentations, or large warm poultices applied over the whole of the abdomen, frequently procure considerable relief to pain, and afford great comfort to the patient under such circumstances. The treatment must, however, be guided by symptoms, and no very general law can be laid down as to its adoption.

Pain is frequently felt over the region of the injured part for some time subsequent to recovery: such pain indicates the necessity for care on the part of the patient; for secondary inflammation may be set up by any prolonged or reckless indulgence in exercise or violent exertion. *It is always impossible to estimate the amount of injury in the most favourable cases, or to calculate the amount of blood extravasated.* With judicious treatment in the early stages of the injury, the rupture of the liver may have united, and the effused blood may have commenced to disappear, but adhesions of the peritoneal surfaces about the injury probably exist to some extent; if by too active movements on the part of the patient these adhesions become disturbed or destroyed, all previous benefit may be entirely lost, and a fatal termination be the result.

The following case indicates the extreme importance of strictly maintaining the recumbent posture after severe collapse.

A man, æt. 40, was admitted into St. George's Hospital in May 1845, under the care of Mr. Cutler. The patient was in a state of collapse, and complained of intense pain over the abdomen, which was considerably distended; some of the ribs on the right side were fractured. The pain gradually subsided, though the patient remained very exsanguine. He appeared to be gaining some strength, when he died suddenly, three days after the accident, on attempting to raise himself up to get upon the bed-pan. The cavity of the peritonæum contained a large quantity of blood. The convolutions of intestines were glued together by the fibrin of the extravasated blood, which had partially lost its colour, and formed slender adhesions. There was an extensive rupture of the liver. The ruptured parts were well adapted to each other, and pretty firmly united by the fibrin of the extravasated blood.

That a rupture of the liver may unite, and that a patient need not die from the effects of such an injury, there can be no doubt: the following case is an illustration.

A man, æt. 38, was admitted into St. George's Hospital, under the care of Mr. Cæsar Hawkins. The patient had fallen from a hay-rick, and struck his back against a log of wood. There was complete loss of voluntary motion and sensation in the parts below the nipples. There was considerable collapse, which continued for several hours. The urine drawn off contained a large proportion of blood. Sloughs formed upon the back, &c., and death occurred exactly three weeks after the accident. The body of the seventh cervical vertebra was broken into fragments, and the spinal cord corresponding to this vertebra was softened and diffluent. The cavity of the peritonæum contained a little bloody serum. An extensive rupture was found on the upper surface of the right lobe of the liver; this rupture, which measured five inches in length, was perfectly united, with the exception of some few points, where the peritoneal coat still remained broken; but no lymph was found on the serous membrane, which retained its polished surface. *The rupture did not extend very deeply into the organ.**

Such a rupture as the above, occurring without other mischief to the body, may reasonably be considered as by no means fatal in its character, nor in this instance can the injury to the liver be looked upon as at all implicated in the cause of death.

In conclusion, from the results of the cases quoted, and for the reasons adduced, we may fairly state, that the treatment of the *convalescent* is a matter of as great importance as that of the patient in the early days of an injury suspected to be laceration of the liver.

Rupture of the *gall-bladder*, or of the common duct, may occur without rupture of the liver. The symptoms are generally marked —considerable pain in the region of the injury, excessive collapse, and great anxiety. Death is generally rapid; and post-mortem examinations have detected the escape of the bile into the cavity of the peritonæum.

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* Cases of ruptured liver, by Mr. Athol Johnson, *Med.-Chir. Trans.* vol. xxxiv.

Mr. Poland relates the following case. "A boy received a blow on the abdomen, followed by great pain, and speedy death. There was found extravasation of bile, and rupture of the ductus communis choledochus, with lymph thrown out in the neighbourhood."*

Dr. Fergus has recorded an interesting case of rupture of the gall-bladder, in the thirty-first volume of the *Med.-Chir. Trans.* A boy, æt. 17, fell off the shaft of a cart, the wheel of which passed over the abdomen, just below the false ribs. The boy complained of pain in the abdomen, but not of a severe character; the amount of shock was trifling. In the night following the accident, severe pain commenced in the abdomen—the countenance became anxious, and the pulse small and rapid. These symptoms were actively treated; and he improved so much, that on the fifth day after the receipt of the injury he was considered convalescent, and was allowed to get up. Two days subsequently, he was so far recovered, that the question of his quitting the hospital was entertained, when about noon he was suddenly seized with extreme pain and a sense of tightness in the abdomen: in an hour the pain had extended all over the abdomen, and was increased by pressure; the countenance was full of anxiety, and the pulse small and rapid; the symptoms present were those of acute peritonitis, from effusion of foreign matter into the cavity of the abdomen. Notwithstanding the most judicious treatment, the symptoms increased in severity, and the patient died on the ninth day after the first receipt of injury.

On opening the cavity of the peritonæum, an immense gush took place of a dark liquor, having precisely the colour and odour of bile. The intestines were roughened from the effects of peritonitis, and shreds of lymph were floating in the dark fluid. "The liver was lacerated in the direction taken by the broad ligament, quite through its substance, and to a depth from the thin edge of two inches and a half; another laceration extended about two-thirds of the length of the convex surface, in a transverse direction. The omentum was found rolled up in a mass underneath the liver, and slightly adherent to it, of a dusky dark colour, and gave way under the least pressure. The neighbouring portion of the transverse colon was of the same colour, and nearly as fragile. The gall-bladder was ruptured above, near the junction of the hepatic with the cystic duct, at a spot in immediate relation and in contact with the mass of omentum above described; the gall-bladder was quite empty and contracted."

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* *Prize-Essay*, by Alfred Poland.

The question arising from the history of this case is, whether the secondary and sudden attack of inflammation might not have been dependent on the extravasation of bile, just previous to the attack of pain—this extravasation being the result of some of the adhesions, between the omentum and the gall-bladder, becoming broken up by accidental causes. The case points out, in its progress and by its result, the very great importance of enforcing rest and quietude in all injuries of the abdomen, such as this boy had suffered. We may consider that, after an injury to the abdomen, a patient is not safe under the period of a fortnight, even if he be entirely free from all symptoms.

The *spleen* is frequently ruptured in injuries of the abdomen. Such lacerations generally occasion considerable internal hæmorrhage. The symptoms attendant on any rupture of the spleen will barely justify an opinion being hazarded, whether the laceration be in the spleen or in the liver. The symptoms do not vary much in either injury; the only points which can in any degree guide our diagnosis are, the nature of the blow, and the situation of the injury. If the laceration of the spleen be more than very superficial, hæmorrhage will probably be more considerable than it would be in a similar extent of laceration of the liver, and death will rapidly follow.

Though rupture of the spleen need not prove *immediately* fatal, secondary mischief may supervene, and *ultimately* produce death.

A man aged 24 was admitted into St. George's Hospital, under the care of Mr. Cæsar Hawkins, August 29, 1845, having fallen from a scaffold the height of about twenty feet. On admission, the patient did not appear to suffer more than from a serious shake; but about three hours afterwards he became collapsed almost like death, and was scarcely conscious for a short time. He gradually recovered from this condition, and then complained of pain in the left lumbar region. During the following nine days he had repeated fainting-fits; but these disappeared subsequently, and he appeared to be gaining strength slowly. In October, he was sufficiently recovered to sit up, and even walked one day from his bed to the fire-place in the accident-ward, a distance of about 20 feet. Subsequent to this exertion, he was again attacked with faintings, increased pain, cough, &c., and he died November 15, about eleven weeks after the accident.

The cavity of the left pleura was divided by adhesions: the upper half contained serum and flakes of lymph; the lower half was filled with sero-purulent fluid and lymph. The pleura corresponding to the latter surface was covered with a thick layer of lymph. The surface of the left lung, corresponding to the diaphragm, was adherent to the latter. A large foul abscess occupied the lower portion of this lung; and this abscess communicated with a large cavity containing pus, between the lung and the diaphragm. Corresponding to the lower surface of this cavity, was a ragged opening in the diaphragm, about an inch in length, through which the abscess in the pleural cavity and lung communicated with one in the cavity of the abdomen, behind and to the left of the stomach.

The surface of the peritonæum was throughout of a black colour, as if washed over with ink. There were numerous adhesions of the peritonæum. The posterior surface of the left extremity of the stomach was fastened down by adhesions, in separating which, an abscess containing half-a-pint of pus was found; the walls of this abscess were formed by the stomach and transverse colon, the diaphragm, and the upper surface of the left kidney. The spleen was found ruptured into two portions;—one, the upper portion, being surrounded by pus, and, as it were, in the abscess; the other, the lower portion, being situated in front of the abscess. The inferior surface of the diaphragm corresponding to the abscess was lacerated, from the median line to the extent of six inches to the left side.

Rupture of the kidney is a lesion often met with in post-mortem examinations of individuals whose death has been occasioned by violence. This lesion may, however, occur independent of injury to any other viscus; and the termination may be rapidly fatal. A bruise of the kidney may occur without rupture of the surface; and subsequent inflammation, the result of the bruise, produce abscess, and other more serious mischief.

A gentleman was bruised over the left loin by a fall in hunting, and experienced severe pain in the back on arriving home. He was very judiciously treated for some weeks after the accident, and came under the notice of the author some months subsequently. The bladder was now very irritable; and highly offensive urine, mixed with pus, was constantly passed. There was every evidence of abscess of the kidney: the quantity of pus was sometimes very considerable. The health became gradually deteriorated, and death occurred about two years subsequent to the accident.

The left kidney was entirely destroyed; and in its situation was found a large irregular abscess, with its walls adherent to the surrounding soft tissues, and its cavity continuous with the ureter.

Without much more external evidence of bruise than in the previous case, very extensive laceration of the kidney may result from a blow over the lumbar region. A boy was struck, over and rather in front of the right lumbar region, by the handle of a truck, in consequence of the truck coming in collision with a wagon. From the violence of the blow, the boy was forced against a post of a gateway. He immediately fell, and though able to rise and walk a few steps, he again fell, and was then carried to Guy's Hospital. He was in a state of extreme collapse, with some pain in the abdomen. He died within an hour and a half of the accident.

Externally there was slight ecchymosis over the extremities of seventh and eighth ribs on the right, and the last two ribs on the left side. The cavity of the peritonæum contained a large quantity of coagulated and fluid blood. All that portion of the left kidney above the entrance of its vessels was torn from the lower portion, and was separated from the natural surrounding attachments. The lower portion was not disturbed in its position. There was some ecchymosis on the surface of the liver, opposite to that on the chest.*

In proportion to the severity of the injury, must we anticipate different features in the symptoms which accompany laceration of the kidney. Generally there will be excessive collapse, attended with early vomiting; pain referred to the course of the ureter, as well as to the lumbar region; retraction of the testicle, and frequently great pain referred to the testicle itself and to the lower part of the abdomen; and numbness of the upper part of the thigh. All these symptoms will probably increase in severity, should the patient survive, and infiltration of urine occur. The urine drawn off will be high-coloured and scanty, and will generally be much tinged with blood, often containing a very large proportion of blood. There will frequently be observed, passed through the catheter, long, thin coagula, the casts of the ureter, taken by the blood, as it coagulates in its passage to the bladder.

Should the rupture of the kidney be confined to the anterior surface, and any escape of urine occur through the lacerated part, acute peritonitis will rapidly follow. If the rupture be confined to the posterior surface, and urine be extravasated into the sub-serous cellular tissue, though the symptoms may, in the first instance, be less indicative of peritonitis than in the former condition, suppurative inflammation will soon be marked by its characteristic symptoms; and rigors, high fever, typhoid tongue, and œdema of the parts in the neighbourhood of the injured organ will telegraph the mischief immediately threatening life.

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* *Prize-Essay*, by Mr. Poland.

There is no question, however, that a rupture of the kidney need not be necessarily fatal. The following case is a fair illustration of recovery from such an accident. A man, aged thirty-seven, in June 1858, was taken to St. George's Hospital, having been kicked by a horse. The patient was very faint on admission, and became so much worse after a very short time, that it was supposed he was dying. However, he rallied by degrees. After a short period, a swelling was observed in the region of the liver. The belly commenced to swell, and continued to do so for some time. The urine at first passed was mixed with blood; on the day following the injury, there was less appearance of blood; and, subsequently, the urine was free from blood. He gradually recovered under careful treatment, so as to leave the hospital, July 20th, about six weeks after the accident, in a pretty good state of health and comfort. On the 14th Dec. 1859, he was readmitted, suffering severely from anasarca, oppressed breathing, and urine loaded with albumen. He died on the 22d Dec.

There were numerous adhesions uniting the right lobe of the liver to the diaphragm, but there were no absolute marks of recent rupture. Both kidneys were small, granular, and full of cysts. The cellular tissue around the right kidney was much consolidated. A large clot of blood occupied the pelvis and the interior of this kidney, and communicated also with the exterior of the organ, where a considerable quantity of coagulum lay in the sub-peritoneal substance around the gland. The line of rupture of the kidney could be faintly traced through the substance of the gland. The blood was solid, and only partly decolorised. The ureter was completely impervious with coagula.*

We may conclude that recovery is a result almost entirely dependent on the extent of rupture; if the latter be slight, recovery may readily occur,—if extensive, treatment is hopeless, and death certain.

Absolute rest is the first consideration in treatment. Should vomiting or pain set in, opium should be administered freely, care being taken to relieve the bowels moderately. The urine should be drawn off, in order to ascertain whether blood be contained in the bladder; and should this be the case, the use of the catheter should be had recourse to daily, until the urine becomes clear. Supposing the mischief to have been confined to the posterior surface of the kidney, and we have reason to suspect extravasation of urine through the wound, we must be prepared for suppuration. Frequent and careful examinations should be made, in order that an exit may be secured for the matter, as soon as its existence is suspected; we would strongly urge the advantage of a premature opening, in anticipation of the formation of matter, rather than that any delay should occur in giving it vent, when once established. Suppuration in the lumbar region spreads rapidly, and produces intense constitutional irritation, and will prove in most instances rapidly fatal. But should matter extend downwards and forwards, free incisions are the only means which offer a chance for life.

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* *Path. Soc. Trans.* xi. 140.

In the 27th vol. of the *Medical and Chirurgical Transactions*, Mr. Stanley has reported two cases of ruptured ureter. A boy, aged nine, had the lower part of his body squeezed between a wheel and the curb-stone. Severe contusion of the soft parts around the pelvis was the result, with inability to walk, and great pain at the lower part of the abdomen. Much ecchymosis ensued, and extensive suppuration in the subcutaneous tissues round the pelvis; and several ounces of matter were discharged through a puncture near the left sacro-iliac symphysis. By the end of the sixth week, recovery of the injured soft parts round the pelvis had considerably advanced, when attention was drawn to a fullness on the right side of the abdomen—a circumscribed oblong swelling, extending from the base of the chest to within a short distance of Poupart's ligament; anteriorly terminating abruptly at the linea alba, posteriorly extending into the lumbar region, but without a distinct boundary. Pressure produced no pain, but fluctuation could be recognised. The urine passed naturally, as it had done throughout, and the passage of the catheter proved that none was retained in the bladder. A small puncture was made in the swelling, and a little clear yellow fluid escaped. The fluid was situated immediately beneath the abdominal muscles. Three weeks subsequent to the first puncture, the swelling being more tense and pointed, a trocar introduced midway between the last rib and crista ilii, drew off 51 oz. of clear yellow fluid. Eleven days afterwards, 58 oz. of clear yellow fluid was drawn off; sixteen days subsequently, 64 oz.: nearly three months afterwards, 72 oz. Three weeks after this, only 6 oz. was removed. "From this period the swelling was without increase, or obvious diminution; it still extended from the linea alba into the right lumbar region." At several subsequent periods Mr. Stanley saw the boy in good health, the abdominal swelling still distinct, but slowly diminishing. The fluid drawn off was slightly alkaline, highly albuminous, specific gravity 1008, depositing no precipitate, and destitute of phosphates and lithic acid. In some of the fluid taken away at the later operations, there were most unequivocal evidences of urea. "*The analysis of the fluid seemed to justify the conclusion that the fluid was urine.*"

The second case was that of a woman who was knocked down by, and pushed some way before the wheel of a cart. She was much hurt in the right hypochondrium, where pressure gave considerable pain. In a few days the general distension and pain of the abdomen had subsided, but there remained a circumscribed swelling in the right hypochondrium. This swelling increased, and after some days a feeling of deep fluctuation was discovered. The fluid advancing nearer to the surface, and the constitutional symptoms indicating the occurrence of suppuration, the swelling was punctured with a small trocar, and between two and three pints of straw-coloured urinous-smelling fluid drawn off. The urine from the bladder had throughout passed freely and in full quantity. In ten days subsequent to the first puncture, a trocar was again passed in, and about six pints of fluid drawn off. Much relief was at first afforded, but subsequently the patient sank, and died in the tenth week after the accident.

"A large cyst was found on the right side of the abdomen, behind the peritonæum, extending upwards to the diaphragm, and downwards to the pelvis. The boundaries of this cyst were formed by lymph and thickened cellular tissue; within it was a large quantity of fluid, presenting the characters of a mixture of pus and fœtid urine. A passage was found extending from the upper part of the cyst into the pelvis of the right kidney. The aperture in the pelvis of the kidney was large and irregular; the appearances were such as might be expected to result from laceration of the membranous structure composing the pelvis. The liver presented in its anterior surface the marks of a slight laceration of its tissue, which was in progress of healing."

Mr. Stanley adds: "It will, I presume, scarcely be doubted, that the case first stated was an instance of lesion of the urinary apparatus, probably a slight laceration of the ureter; permitting the escape of urine slowly into the cellular tissue behind the peritonæum. Both cases illustrate the difficulties that may arise in the diagnosis of such injuries. They show, moreover, that the rupture of the ureter, or pelvis of the kidney, may present this remarkable feature, when contrasted with the consequences of a rupture of the bladder, —that, whilst in cases of the latter injury, symptoms immediately arise, directly pointing to the organ which has suffered, in cases of the former kind (the lesion of the ureter or pelvis of the kidney), no symptoms may immediately arise leading to a suspicion of injury to any part of the urinary apparatus."

We have already alluded to the possibility of recovery after laceration of a kidney on its posterior surface. The cases recorded by Mr. Stanley tend to confirm this view; and they also indicate the advantages of an early exit being given to the contents of any abscess, or cyst, the result of extravasation of urine. Regarding this point of treatment, Mr. Stanley observes: "It may, however, be a question, whether the best proceeding would be gradually to withdraw the fluid by repeated punctures of the cyst, and thus to favour the collapse and adhesion of its sides, or whether the urinary cyst should be punctured at its lowest part, in the view of maintaining the aperture free for some time, that the fluid may drain from it." Provided the fluid be at all purulent, the latter method of treatment would no doubt be most judicious.

WOUNDS.

1. *Wounds of the parietes without protrusion of viscera.* We now enter upon that division of our subject which treats of wounds of the abdominal wall, occasioned by a variety of weapons or instruments, without injury to, or protrusion of the viscera. Wounds of the walls of the abdomen are very common, and occur from a great variety of sharp or pointed substances, intentionally or accidentally thrust against, or that suddenly come in contact with the surface of the belly.

Sharp or pointed instruments usually produce clean incised or small penetrating wounds. The larger wounds of the abdomen are the results of persons being caught on hooks, or impaled on iron spikes; falling on china, or through glass; being tossed by horned cattle, or lacerated by the teeth of carnivorous quadrupeds. The extent and character of such wounds will therefore vary in every possible degree, and will depend in as great a measure upon the amount of force by which the instrument of injury is propelled, at the time of the accident, as upon the shape of the instrument and the direction in which it enters the body.

Superficial incised wounds of the abdominal wall are not generally dangerous in their character, nor troublesome to manage, provided the viscera escape bruise or other injury, at the time of the accident. Lacerated wounds, when superficial, may also be considered free from much danger. But deeper wounds, whether incised or lacerated, without injuring the peritonæum, are more serious; from the fact, that there is always a liability to suppuration burrowing deep, and extending in various directions under the muscles and fasciæ of the abdominal wall. The principles laid down for the treatment of wounds in general must be applied to those of the abdominal wall. Hæmorrhage, if it exist, must be arrested. Care must be taken to clear the wound of any foreign substance accidentally lodged in it; such as glass, china, or portions of instruments broken off by the force of the blow which inflicted the injury. It has frequently occurred that large foreign masses have been overlooked, and allowed to remain buried, for many months, in the muscular wall of the abdomen, after an accidental gap made by some sharp cutting material.

A sailor was admitted into St. George's Hospital, complaining of pain over the right lumbar region; produced apparently by some solid substance lodged underneath the integuments. Mr. Babington cut down upon the mass, and extracted the shaft of an originally three-pronged steel fork, now minus a handle, and with only two prongs attached, one prong having been broken off some time previously.

Scrupulous attention having been paid to the condition of the wound, and it having been ascertained to be free of any foreign substance, the treatment should be very simple. The abdominal muscles are to be relaxed by position, especially if the edges of the wound have the least inclination to retract. As a rule, sutures will be found most advantageous and effective in approximating and retaining the edges in apposition. Metallic wire sutures appear to offer many advantages over silk, in such cases.

It must, however, be borne in mind, that in wounds of any depth about the abdominal walls, especially in the thicker parts, or wherever the muscles overlap each other, it will be found difficult, if not impossible, to maintain perfect apposition of the whole surface of the cut. There is always in such wounds a tendency for fluid, serous or sanguineous, to accumulate between the surfaces at the deepest parts. The existence of such fluid may be followed, in a comparatively short time, by foul suppuration; which, if allowed to remain confined, would produce alarming constitutional disturbance.

A man, æt. 31, was admitted into St. George's Hospital, on the 22d of May 1839, with femoral aneurism on the left side. The external iliac artery was tied by Sir B. Brodie on the 30th of May. On the evening of the day of the operation, there was much pain about the wound, and the parts were very sensitive to pressure. The tongue was already brown and dry. On the following morning, the pain was more diffuse, but less intense; the tongue still brown and dry. The left side of the abdomen was hard and tender to the touch. The next morning, June the 1st, the pulse was 136, and small; the tongue brown and dry; countenance anxious; pain only referred to the neighbourhood of the wound. The adhesions of the wound were now broken down by Sir B. Brodie, and *much sanious putrid fluid immediately escaped.* The same evening the patient felt relieved; and the tongue became rather more moist. Subsequently, he continued to improve, and although some time recovering, he was entirely restored to health, and left the hospital about seven weeks after the operation.

In the treatment of the various wounds of the abdominal wall, however produced, it is always necessary to bear in mind, that the treatment should be somewhat modified by the locality of the mischief. For instance, in the epigastric region, a wound is apt to gape, more than when situated in another part; on account of its proximity to the ends of the ribs, which tend to keep the integuments in that region always somewhat on the stretch. It will, therefore, be uniformly requisite to have recourse to sutures to maintain perfect apposition of the cut surfaces. If, again, the muscles are cut or torn, on either side, transverse to the direction of their fibres, attention should be more especially directed to the position of the body, to relax those muscles. If the wound be in the iliac region, it may be more formidable in its real than in its apparent character; not so much from its extent as from its depth and its direction; and from the risk of the iliac arteries, or their numerous branches, being punctured or bruised.

We have already stated that if hæmorrhage exists, it should be arrested. The treatment of hæmorrhage does not fall within the province of the present essay; but perhaps we shall be excused if we trespass out of our province on this one occasion, and speak an extra word or two of caution to the practitioner who may have to deal with hæmorrhage in a wound of the abdomen. If there be severe hæmorrhage, and the wound not sufficient to allow the bleeding mouth of the vessel to be seen, no hesitation need be felt regarding treatment. The wound should be enlarged,—enlarged until the wounded vessel can be seen, *and can be secured.* We need not fear hæmorrhage so long as such a wound is open, and we can place a finger on the bleeding point. When the Surgeon trusts to external pressure, and closes the wound without securing the wounded artery, then there is abundant cause for anxiety. If these principles be of importance in hæmorrhage of ordinary character, they are tenfold important when applied to the treatment of wounds in the region of the groin, or the neighbourhood of the crest of the ilium.

If hæmorrhage be present from a punctured wound, but not in sufficient quantity to indicate the necessity of enlarging the wound, for the purpose of securing the wounded vessel, the wound should not be closed, otherwise much extravasation may occur. To close such a wound under such circumstances is likely to entail extravasation among the deeper tissues, to be followed perhaps by much suppuration. It will be far more prudent to leave a punctured wound with merely some light application over it, such as wet lint, and thus permit oozing to continue unchecked, than attempt to interfere with such bleeding by pressure.

Punctured wounds of the abdominal region, as in all other parts of the body, partake of a more complex and dangerous character than the incised or lacerated varieties. It is frequently difficult, sometimes impossible, to ascertain the extent of the mischief, or foretel the evils about to occur in a punctured wound of the abdomen. Mr. Poland, writing on such wounds, justly observes that "they are not unfrequently followed by inflammation, suppuration, erysipelas, prostration, and death." Punctured wounds prove most troublesome when they extend below the fasciæ of the abdominal muscles, and give rise to suppuration. In such instances the mischief spreads rapidly in the deeper cellular tissue, and between the layers of muscles, unless early relief be afforded by freely extending the original wound. In instances of the above injury, if the external wound be kept closed, and much extravasation have occurred, the suppurative stage occasionally produces excessive constitutional disturbance, and may even prove rapidly fatal.

We would lay it down as a rule, firstly, that *in punctured wounds* of the abdominal wall, if *any* hæmorrhage be present, but not sufficient in amount to justify or indicate an enlargement of the wound for the purpose of applying a ligature to the bleeding vessel, the exit of the flowing blood through the orifice of the wound from the injured artery or vein should not be checked by outward applications. By far the least of two evils will be rather to allow the blood an escape externally, than by external appliances to insure its accumulation in the tissues surrounding the wound. We would lay it down as a rule, secondly, that if hæmorrhage be at all free, the wound should be enlarged sufficiently to allow the bleeding vessel to be secured, and no dependence should be placed on pressure to restrain such hæmorrhage. We would also lay it down as a rule, thirdly, that with the earliest suspicion of suppuration the wound should be freely opened, and a ready escape afforded to the blood, serum, or pus now collected within.

The extent of a punctured wound will always to some degree regulate the subsequent amount of mischief. If it penetrates through the muscles, but not the peritonæum, the wound may prove fatal from peritonitis secondary to the suppurative stage, if not fatal from peritonitis the immediate result of the accident.

Under all circumstances, therefore, the utmost precaution in treatment is necessary. Perfect rest; relaxation of the abdominal muscles, by a posture somewhat bent forwards; the stomach and bowels to be kept moderately empty by the administration of fluid food only; and the administration of opium as indicated by symptoms, will constitute the chief points of medical management. The local treatment of the wound is not a consideration of importance here; if there be suppuration, *the point* beyond all doubt is, that it have free vent; irrespective of *that*, the treatment is of the simplest kind. Peritonitis supervening on these accidents cannot often be met by active or heroic treatment; leeches should not be spared if necessary and if the patient can bear the loss of blood. The practitioner will find in most cases an invaluable auxiliary in opium; but science, judgment, and experience must regulate the treatment in each individual case, according to symptoms. No definite law can be applied to the complications which so often arise in the progress of these cases.

Suppuration will be indicated by increase of heat about the wound, redness, tumefaction, and tenderness. These symptoms will soon be followed by heat of body, increase of pulse, thirst, a brownish dry tongue, rigors, and perhaps wandering sleep or delirium. It may even happen, if the wound be deep, and the symptoms severe, that the constitutional disturbance is so rapidly increased in amount that death takes place in an unexpectedly short period. It is well, at all times, to be very guarded in any opinion offered to the anxious relatives of a patient, the subject of such an accident. In rapidly fatal cases the cellular tissue and the fascial interspaces will usually be found infiltrated with pus and lymph to a surprising extent; and not unfrequently purulent effusion will be observed on the surface of the intestines.

Should the patient survive the early inflammatory and suppurative stages following a punctured wound of the abdominal wall, the suppurative action may spread at intervals in various directions, and abscess after abscess present in different positions, until he becomes worn out and dies; or sometimes when the patient may be said to have placed his hand on the door leading to death's chamber, the symptoms commence to show a favourable turn. Suppuration becomes healthy in character and diminished in quantity. Sinuses gradually close, and time slowly replaces the sufferer in a position of safety; he rises from his couch convalescent, but most probably somewhat crippled, either from suppuration having extended below Poupart's ligament and having implicated the muscles of the thigh or neighbouring articulations, or from the long contracted position in which, for many weary days, he has been confined to bed.

In the abdominal wall a condition sometimes remains, after a wound of the parietes has healed, to which the attention of the Surgeon must be directed—we allude to the protrusion of the parietes at this part. This protrusion is the result of the action of the abdominal contents against the cicatrix, which thins out and yields more readily than the natural healthy abdominal wall. Such a protrusion constitutes one of the forms of ventral hernia. Usually the protruding viscera push before them evenly the now stretched cicatrix and surrounding tissues, so that the base of the prominence is larger in circumference than any other portion. There is no so-called neck to the cavity which contains the viscera, so that the latter run little risk of strangulation. No difficulty is encountered in an attempt to push back the contents of the prominent mass; the difficulty is to restrain the viscera from again bulging forward. As there is no danger of strangulation, it is only necessary to support the parts by means of a large pad and a well-adjusted bandage.

2. *Wounds of the abdomen, with protrusion of the bowels or portions of other viscera* through the aperture, are by no means rare accidents; such a protrusion constitutes a hernia without a sac.

The character of the wound will in a great measure regulate the amount of the protrusion, just as the situation of the wound will to some extent permit only certain viscera or portions to be protruded. In punctured and small wounds a part of the intestine, omentum, or both, may escape through the aperture. In incised or lacerated wounds larger portions of either, or both, and even portions of the stomach, liver, &c. may protrude externally. In the former kinds of wounds the protruding viscera are very apt to be constricted at their point of exit from the cavity of the abdomen; a condition little liable to happen in the lacerated or large incised wounds. The viscera most frequently met with protruding through wounds of the parietes of the abdomen are the small intestine and omentum; for as the mobility of the part, so is the greater facility of its displacement. But stomach, large intestine, and even liver and spleen, have been found lying outside the abdomen in wounds, the result of accidents such as we are about to consider.

We presume, as the first consideration in treatment, that the Surgeon, in dealing with protrusion of any portion of the viscera through a wound of the abdomen, has a recent accident before him. In such a case he has no time to lose in returning the protrusion, whatever it may consist of, whether omentum, intestine, or other tissues. What considerations should guide his proceedings? In the first place, having by careful examination satisfied himself of what the protruded portion consists, he must see that no foreign substances adhere to, or are entangled in, the protrusion. If such be the case, the parts must, with gentleness and caution, be cleansed with tepid water, to free the peritonæum of all extraneous matter, and to secure a *perfectly* clean surface. If the portion protruded is *apparently* omentum alone, care must be taken to ascertain that bowel is not wrapped up in the folds, or lying at the base of the protrusion near the aperture of the wound. If the protrusion consist of intestine, care must be taken to ascertain that no injury has been occasioned to the peritonæum, or that the coats have not been ruptured. These points being ascertained, the parts being sound and healthy, and the surface perfectly clean and free from extraneous matter, the replacement of the protruded mass into the abdominal cavity should at once be proceeded with. A ready replacement is not always easily effected. In such a difficulty it will sometimes answer to draw out a small portion more of the intestine, and then gently pressing on it, and propelling its contents into the interior, the protruded bowel will itself sometimes readily follow. It may happen that such a large amount of intestine or omentum has escaped through the wound, that the protruded portions can no longer be passed back through the opening by which they escaped. Under such circumstances the Surgeon need not hesitate; for as in a case of strangulated hernia, so here, the orifice, or stricture, of the wound should be enlarged. If this alternative be inevitable, care must be taken to avoid enlarging more than the external orifice of the wound, or dividing more than any bands of fascia or fibres of muscles that offer obstruction to the return of the protrusion. The peritonæum should not be interfered with, if this can possibly be avoided. The opening in the peritonæum will readily yield to any extension requisite for the reduction of the protruded viscus; but if the opening in the peritonæum be increased by incision, the enlarged wound will hereafter be found to facilitate, to a most troublesome degree, the re-protrusion of viscera through the peritoneal opening. The external opening being, either of itself or by extension, sufficient for the reduction to be proceeded with, the protruded parts should be gently returned, bowel first, and omentum after it, should both have escaped. The Surgeon should then satisfy himself that all is fairly returned within the cavity of the peritoneal sac. The structures which protruded should not be heedlessly or hastily reduced, for they may be pushed simply between the external tissues and the peritonæum, without having been returned into the abdomen, and they would then still remain subject to the constricting influences of the internal orifice of the wound. In all cases, *subsequent* to the reduction of the parts, the finger of the Surgeon should be gently passed down to the peritoneal aperture, to ascertain whether any portion of viscera still occupies this opening, in which case he should insure perfect reduction previous to closing the wound.

Supposing omentum to be the only structure protruded through such a wound, something depends on the condition, something on the quantity extruded, and something upon the nature of the wound, before we can say, as a rule, return it into the abdomen. If the omentum be quite healthy, recently protruded, not congested, not lacerated—whether it be much or little in quantity—and if the wound permit of its ready return, there can be no doubt that, to return the mass at once, and to close the wound, is the right rule of practice.

If the omentum be bruised, lacerated, dirty from contact with the ground or other material, inflamed or congested, or if the mass be not considerable, but there be much resistance to its reduction, without enlarging the wound, we would recommend a ligature to be passed round the base of the omentum, or a double thread to be passed through it, and each thread tied round it, and the mass anterior to the ligature cut off.

If the protruded mass be very large, and not injured, but the wound not sufficient to allow of a ready return, the wound should be enlarged, and the parts replaced; but if a large portion be in any degree bruised, lacerated, or congested, or if blood be extravasated in its structure, it may be removed with safety, and its removal will be probably less serious than if it were left in the wound to suppurate or slough, as the case may be. In very many cases of inguinal and femoral hernia, it has occurred to the author to consider it desirable to remove portions of omentum, occasionally considerable portions. He has never had reason to regret such a proceeding, but has had occasionally to regret its omission. If such treatment be applicable in the one class of cases, we cannot reasonably condemn it in the other; and under the circumstances above mentioned it appears to be the most judicious, and the most expeditious, towards favouring the recovery of the patient. It must, however, be stated that there are some differences of opinion on this point. The opinion now arrived at is the result of a careful consideration of the practice observed at St. George's Hospital for many years past. Be it remembered, however, that whether the omentum be returned, or whether removed, the external wound should be brought together at once, and should have nothing protruding between its lips, except the ends of the ligature passed round the omentum. The removal of omentum *must never be attempted, under any circumstances*, without the base of the portion to be removed being safely secured by ligature. If this precaution be not heeded, very formidable, if not fatal, hæmorrhage may result from the vessels divided. And again, it is safer to pass the double ligature through the base of the omentum rather than trust to a single ligature tied round it; we thus avoid the possibility of the ligature escaping from off the stump of omentum, which is left in the wound after the greater portion of the protruded mass has been cut away.

With the exception of omentum, all other protrusions of viscera must be invariably reduced, and as early as possible.

It has been already stated that the small intestine is more frequently protruded than portions of other viscera, after wounds of the abdomen; the transverse colon and the stomach come next, each in its order. The wound of the parietes must be extensive to allow of the protrusion of liver or spleen. But yet there are cases on record, and those not few, which bear witness that portions of most of the viscera may escape through an opening in the abdominal wall. In a practical point of view it does not matter what the protrusion may consist of, irrespective of omentum; for, provided the mass be healthy, *it must be returned*. It is only the amount of the protrusion which will to some extent affect the steps of the treatment; for if the wound be small, and the mass protruded large, in all probability the former must be enlarged before the latter can be returned. In lacerated or incised wounds the probability is that reduction is readily effected.

The rules propounded respecting the propriety of reducing the omentum when protruded, will apply to some extent to the treatment of protruded intestine. The latter, when examined soon after an accident, may be found reducible readily through the wound. In such case the precautions necessary are, to see that the intestine is clean—its surface free from dirt, hairs, straw, or other matters which the contact of clothes, &c. may occasion to adhere to the moist peritoneal covering; that the bowel is not bruised or ruptured; that no portion of the instrument which occasioned the wound be lodged among the folds of the intestine. The surface of the bowel must be well cleared of all adherent materials, by being bathed gently with tepid water, and, if otherwise sound, be at once returned into the abdomen.

If the bowel, as regards its integrity, &c., be in a condition favourable for reduction, we may nevertheless find that it is irreducible. This circumstance may be the result of a great amount of viscera protruded, or of the protruded portion having become much distended by flatus, or thickened by congestion,—or of a wound, contracted when compared with the size of the mass external to it. If the difficulty in reduction arises from the smallness of the wound, the means to be adopted have already been mentioned. If such difficulty depends on the distension of the bowel by flatus, that condition may often be overcome by very gently and carefully pressing the air back into the portion of intestine within the abdomen. This attempt, however, may entirely fail, and only by an extension of the wound can a very large mass of greatly-distended intestine be returned into the abdomen. In instances of very large protrusion, with *excessive distension*, to puncture the bowel with an exploring needle, is a practice which has been adopted successfully; but, on the other hand, such practice has been strongly condemned by several writers. It has been urged that the small punctures cannot be of service, as they will soon be filled up by the mucous coat. However, as they are only wanted for immediate relief, this objection is not of much value. Such treatment can only be requisite in extensive protrusion of bowel largely distended, and where there is much difficulty of reduction.

Mr. Tatum reports a case in which he adopted this treatment with success. A patient was operated on for inguinal hernia, and the medical man found, after dividing the stricture, that so large a mass of bowel protruded, that no effort on his part would succeed in reducing it. Mr. Tatum was called in, and, examining the condition of the parts, found the space between the thighs occupied by a large volume of intestine, extending nearly down to the knees.

"It was found to be composed of the whole, with a slight exception, of the jejunum and ileum, enormously distended with flatus, and of a bright-red colour." With a grooved needle, Mr. Tatum made three or four punctures, allowing the flatus to escape by the groove in the needle at each puncture, until the part was collapsed. "By these means the whole of the protruded bowel lay in a collapsed state, not one-fifth of its previous volume. The protruded parts were now readily returned into the abdomen;" and the patient recovered without a bad symptom.*

In all other conditions of irreducible intestine, the wound has to be enlarged before the attempt at reduction can be successful. Great care and much gentleness are requisite in handling a portion of bowel when the reduction is attempted; observing carefully the manner in which the coils of the bowels lie with regard to the wound, the Surgeon should commence manipulation with the portion last descended, and nearest the margin of the opening; and should keep passing up portion after portion by degrees, until the whole mass is returned. This process, though apparently simple in its description, is often very perplexing at the bed-side; such an attempt sometimes appears almost hopeless; for as one portion is pushed back, another portion is forced out of the abdomen. Every precaution is therefore requisite to lessen the muscular action of the parietes: the abdominal wall must be perfectly relaxed; the patient made to lie on his back, with his shoulders well raised, and the thighs perfectly flexed on the pelvis. If it be necessary to enlarge the wound, we should be careful to enlarge it in the direction of the muscular fibres, and away from the course of the epigastric artery, and to avoid enlarging the opening in the peritonæum if possible. It is necessary to ascertain that the bowel when reduced is returned entirely within the peritonæum.

The bowel protruded may be not only irreducible, but it may, as occasionally in herniæ, be also strangulated: of course this condition occurs only when a patient has been left, for some time after the accident, without medical aid or relief. The amount of mischief to the bowel, resulting from the strangulation, must be our guide as to whether any *positive* benefit is likely to be derived from its reduction; but, short of a state of gangrene, it were better to return the bowel at once, and so secure the best chance for the recovery of the patient. The wound should at once be enlarged, and the protrusion returned.

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* "Cases of Hernia, with remarks," by Thomas Tatum, *Medical Times and Gazette*, April 29th, 1854, p. 433.

In a condition of gangrene, if the gut is returned into the cavity of the peritonæum, death must ensue. The only treatment which holds out a prospect of life, with so much mischief, is to open the bowel at once, to allow its contents to escape, and then to leave the intestine, now adherent to the margins of the wound, in undisturbed possession of its new attachments. An artificial anus will thus be established. We shall hereafter consider the treatment of this lesion.

The treatment of all wounds of the abdomen, after the reduction of protruded viscera, whatever the character of the latter, is simple enough. The parts around the wound must be relaxed, and this relaxation be maintained by position. It is desirable to close the wound at once, and, in most cases, sutures are to be preferred, to secure uniform apposition of the edges, as well as to maintain perfect support. In the application of the sutures, it is desirable that the peritonæum be included in their hold as well as the more superficial tissues. Such a proceeding should not be considered more dangerous than if the suture be simply confined to the superficial margins of the wound. By including the peritonæum, we secure the perfect apposition of its edges, and thus prevent the escape of intestine into the gap of the deeper part of the wound, and also to a great extent prevent the products of suppuration escaping into the cavity of the peritonæum. Whenever a ligature has been applied to the omentum, the ends of that ligature should be allowed to hang out of the wound, between any two sutures applied to its margin, until separation from the hold on the omentum takes place. The period of separation varies from nine or ten days to sometimes a fortnight or three weeks. The dressings applied to the wounds cannot be too simple or too light.

The following case is a fair specimen of recovery after a large lacerated wound of the abdomen. A man, whilst leading a prize-bull to an agricultural show, was suddenly attacked by the animal, and gored at the lower part of the abdomen. The patient was seen soon afterwards by Mr. James of Uxbridge, who found a large quantity of the small intestine and omentum protruding through a lacerated wound, some eight or nine inches in length, passing directly across the body, midway between the umbilicus and pubes. When seen first by Mr. James, the intestines were covered with dirt, and had adhering to their surface particles of straw, &c. The parts were carefully cleansed with tepid water, and all extraneous matter removed from the peritonæum; the intestines and omentum were then returned into the cavity of the peritonæum, and the edges of the wound brought together by several silk sutures. The man was then sent in a cart to St. George's Hospital, a distance of fifteen miles, and placed under Mr. Cutler's care. On the morning following admission, the wound looked perfectly united. There was some tenderness about the abdomen, but nothing of a severe character. The pulse was not irritable; the tongue rather white; but the patient stated himself to be pretty comfortable. He had not one bad symptom subsequently. The wound entirely united by first intention; and the man left the hospital in a short time quite well, and without any discomfort from the injury.

The stomach, portions of the liver, or the spleen, may escape through a wound in the abdominal wall, as we have already stated, but the principles laid down for the treatment of protruded intestine will, in a great measure, apply to these complications. Mr. S. Cooper mentions that in his part of the Military Hospital at Brussels, after the battle of Waterloo, the number of patients admitted with protrusions of the viscera was much more considerable than previously he had any idea of meeting with,—protrusions of stomach, bladder, mesentery, omentum, and intestine.

Dr. John Macpherson, of the Bengal Medical Service, relates a case of spear-wound, with protrusion of liver, in a Hindoo. The wound was an inch in length; about three inches above the umbilicus, and about two inches to the right side. Through the wound, a triangular portion of liver protruded. There was much hæmorrhage, but no apparent wound of the liver. It was found impossible to return the protrusion without enlarging the wound. A ligature was tied round the base of the prominent piece of liver, and the greater portion cut off; a double ligature secured the remainder to the edge of the wound. The patient recovered.* We may remark that the natives of India are singularly happy in recovering after surgical operations.

Many other cases could be added to illustrate not only the possibility, but the fair prospect of recovery after wounds of the abdomen with protrusion of viscera, provided the viscera are not injured nor the peritonæum bruised. The following case, however, is a marked instance of an unusual character of accident, as well as an illustration of a difficulty, which creates some kind of doubt as to the most advisable treatment to be adopted. For the notes of the case the author is indebted to his friend Mr. Godson of Barnet. "A woman, æt. 63, the 11th July 1854, was seriously injured by the brutality of four men committing rape upon her. The following morning she walked nearly a mile, with several convolutions of the small intestines protruding externally through a rent in the vagina. The intestines, when seen by Mr. Godson, had particles of dirt and straw adhering to their surface, but the woman did not appear to suffer very much pain, though apparently very ill. The parts were cleansed with tepid water, and the patient was put to bed in the workhouse. Mr. J. H. Green subsequently saw the patient, in consultation with Mr. Godson. All attempts at reduction were found unavailing; nor did there appear any possibility of enlarging the wound to facilitate the reduction of the bowel. The protruded portion became gangrenous on the 14th, but the patient lived until the 21st, ten days after the injury. The rent was found in the anterior wall of the vagina, close to the uterus, and running into the cavity of the peritonæum between the bladder and uterus."

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* *Medical Gazette*, Jan. 1846.

It is somewhat difficult to advise what proceedings should be adopted, in any case similar to the above. There appeared no possibility of returning the bowel by manipulating the protrusion itself; nor did it appear possible to get at the opening to enlarge it, the vagina being filled with intestine. The treatment which appears most suited to such a case, and which should be adopted if the result of this case is to influence us, would be to make an incision through the abdominal wall in the median line and below the umbilicus, and to introduce the hand, so that the bowel might through this opening be drawn back into the abdomen from the vagina. The treatment would be desperate; but without some effort at reduction such a case is hopeless. Such treatment ought only to be adopted as a last resource, and only after the failure of local attempts at reduction, assisted by raising the lower part of the trunk, so as almost to place the patient with the head below and the pelvis above.

Protrusions of the spleen have been recorded as successfully treated, either by reduction, or even by removal. One singular case of the latter description is to be found in the *Phil. Trans.* vol. xl. p. 425, in which instance the patient recovered, and lived without apparent suffering from the loss.

In protrusions of the bladder, it is always requisite to introduce a catheter through the urethra without loss of time, and to draw off the urine. This treatment will, we believe, in all cases sufficiently reduce the size of the protrusion to permit its reduction without difficulty.

The latter protrusion may occur subsequent to a wound of the abdominal wall without a wound of the peritonæum. The protrusion will only occur, under any condition of wound, when the bladder is somewhat distended, for an empty bladder lies behind the pubes in close contact with the anterior bony wall of the pelvis. Provided there be no injury to the bladder, the simple protrusion, unaccompanied by peritoneal injury, is an accident that may produce very little subsequent inconvenience, even if the whole of the external wound does not unite immediately. If a wound of the lower portion of the abdomen be complicated with wounded peritonæum, and a punctured bladder permit the escape of urine into the sac of the peritonæum, severe peritonitis rapidly follows upon the injury, and death soon takes place. The further consideration of lesions of the bladder will be found under the head of INJURIES OF THE PELVIS.

Before concluding this portion of the subject, it may be mentioned that occasionally, but rarely, subsequent to a wound of the abdomen, peritonitis may terminate in the formation of an abscess, confined to a proportionately small space in the peritoneal sac, and that such abscess may of itself open externally, or require the aid of the knife to allow of the exit of matter. We can rarely anticipate a favourable result in such a case; for we should generally find the intestines matted together in the neighbourhood of the abscess, and frequently a fistulous communication established between the abscess and the intestines forming a portion of the circumference of the sac. In such cases suppuration and diarrhœa play upon a system already reduced by previous illness, and the patient sooner or later sinks under the exhausting influences of the local mischief and constitutional disturbance.

3. *Wounds of viscera* may be classed, for the convenience of consideration, into, firstly, those which occur in protruded portions; secondly, those which occur from penetrating wounds of the abdomen.

In the examination of the first-mentioned variety, we have here to consider the nature and treatment of *the wound alone*. All that relates to the management of the protruded bowel has already been fully discussed, and requires no recapitulation.

Wounds of the intestine may vary very considerably in size as well as in appearance, according to the shape and character of the instrument by which the lesion is occasioned; and the treatment must be regulated very much according to the extent of the wound.

A small wound of the bowel, whether of the small or large intestine, produced by some pointed instrument, or by a sharp knife, when seen *immediately* after the injury, would present little more than the wound in the peritonæum, for the deeper gap would almost instantaneously be filled with mucous membrane. The fæces are not observed to escape through so small a wound. In a very short time after the receipt of the injury, the entire wound would be found plugged with mucous membrane, and the latter would soon project above the level of the surface of the peritonæum, become everted over its margin, and thus effectually conceal the exact limits of its orifice. A pair of forceps applied to the intestine at the injured part will enable the Surgeon to raise up this portion, and pass a very fine ligature immediately round the puncture, so as to include it entirely. The ligature should then be tied firmly, and the ends cut off close to the knot. The bowel should be returned as directed.

Some Surgeons have considered it unnecessary, and not even desirable, to apply a ligature round *a small punctured wound of intestine.* They have argued that the mucous membrane so entirely blocks up the orifice in such a wound, that escape of the contents does not occur, and that the application of the ligature is only apt to aggravate the tendency to peritonitis. But it must be evident that the application of a ligature to a wound, however small, of the intestine, will entirely prevent the escape of any fæculent fluid into the peritonæum, and thus will constitute one great measure of safety in treatment; nor is it at all evident that the presence of the ligature is prejudicial. The adoption of such practice has been successful in very many instances.

Mr. Travers, in his work on *Injuries of the Intestines*, has recorded several experiments on animals, the results of which tend to prove that a wound of the peritonæum, complicated with a wound of the intestine, is generally fatal from the effects of peritonitis. All the experiments by Mr. Travers, Dr. Gross, and others, lead to this conclusion, that, upon the infliction of a wound of the intestine, *some* escape of fæculent fluid, though perhaps a very small quantity, takes place, and is the chief cause of the subsequent peritonitis. The escape of the very smallest quantity of such a fluid appears sufficient to produce violent peritonitis; and it appears, therefore, more just to ascribe the peritonitis following a wound of the abdomen, complicated with a wound of the intestine, to some escape from the latter, rather than attribute the mischief to the wound of the peritonæum.

A simple wound of the peritonæum without a corresponding opening in the intestine is a far less serious injury in its consequences than may generally be supposed. Surgeons experienced in operations for strangulated hernia are quite familiar with the following facts: that patients operated on *early in the period of strangulation*, in a very large proportion of cases recover with singularly little inconvenience, and with remarkably slight symptoms; but that the fatality attending operations for strangulated hernia is almost entirely to be attributed to mischief occasioned to the intestine *by delay*, or by unnecessary force applied to the hernia in prolonged, sometimes violent, attempts at reduction previous to operation. The simple wound of the peritonæum is generally considered as by far the most unimportant condition in the treatment of a case of strangulated hernia. A case of femoral aneurism, under the care of the late Mr. Keate, in St. George's Hospital, was treated by ligature of the external iliac artery. The peritonæum was accidentally wounded in the operation, to the extent of about an inch. The patient died a few days after the operation, from causes unconnected with this wound. On examination, the wound of the peritonæum was found perfectly united; there was not the slightest evidence of peritonitis, or any effusion of fluid within the cavity of the peritonæum. A simple wound of the peritonæum need not, therefore, be considered as necessarily productive of fatal peritonitis.

The management of a *large wound* in a protruded portion of intestine is quite a different matter from that of a small wound, and the treatment should also be regulated somewhat by the manner in which the intestine is wounded; viz. whether it be cut more or less across, or whether it be entirely divided. "Before adverting to the consequences of wounds inflicted on the exposed intestine," observes Mr. Travers, "it will be necessary to describe certain appearances, which the wounds exhibit, depending upon the action of the bowel. If a gut be punctured, the elasticity of the peritonæum and the contraction of the muscular fibres open the wound, and the villous or mucous coat forms a sort of hernial protrusion, and obliterates the aperture. If an incised wound be made, the edges are drawn asunder and reverted, so that the mucous coat is elevated in the form of a fleshy lip. If the section be transverse, the lip is broad and bulbous, and acquires tumefaction and redness from the contraction of the circular fibres behind it, which produces, relatively to the everted portion, the appearance of a cervix. If the incision is according to the length of the cylinder, the lip is narrow, and the contraction of the adjacent longitudinal, resisting that of the circular fibres, gives the orifice an oval form." * We have no choice of treatment when called to a case of a large wound of the intestine;—we should close that wound by suture, and return the bowel into the abdomen as quickly as possible. Some little fancy may be exercised in the choice of suture; but *that* is a minor consideration. "I am not aware," says Mr. Travers, "that any formal directions are required for the operation of sewing up a wound of the intestine. Let a small round sewing-needle, armed with a silk thread, be passed near to the lines formed at the bases of the everted lips. The thread is to be carried, at short regular distances, through the whole extent of the wound; the operator being mindful that an equal portion of the edges is included in each stitch. When the suture is finished, let the thread be securely fastened, and cut close to the knot."* The main object in view, in the application of the sutures, is the most perfect adaptation of the edges of the wounded intestine, so that extravasation of its contents be effectually prevented. The intestine is to be returned to its natural bed, without any measures being adopted to retain the wounded portion near the external wound. *No ligature should be used for such a purpose.* The treatment of the internal wound is thus independent and quite distinct from that of the external one. The latter, on the replacement of the bowel, is to be managed as if no other injury had occurred. When the entire cylinder of the bowel is divided, the case is far more serious. A vast number of experiments have been made, to establish some definite rule in the treatment of such extensive injuries: any relation of these experiments would occupy too much of our space, without any beneficial return; and it is therefore necessary merely to confine our remarks to the most practical observations that bear upon this subject.

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* Travers on *Injuries of Intestines*, p. 85.

Mr. Travers states, that the retraction ensuing upon direct division of the intestine "renders this injury irreparable." But there are on record some few cases of complete division of the bowel, in which recovery is stated to have taken place. The condition of the extremities of the divided portion will, in some measure, resemble the margins of a small wound in the intestine; viz. the mucous membrane will protrude from the open extremities, and fold over the peritoneal surface; so that, when the divided portions are brought together, the two opposed surfaces will consist of two surfaces of mucous membrane touching each other. This latter fact has originated numerous theories respecting the treatment of these injuries, and has led to the performance of innumerable experiments on animals, with a view to ascertain the most effectual means by which this *supposed* difficulty might be overcome; viz. that two mucous surfaces in contact with each other could not unite. The results of these experiments have been, that some Surgeons have recommended sutures to be applied in such a manner that the mucous surfaces should be turned in, and the serous surfaces alone brought into contact. Others have invaginated the upper into the lower portion of the divided bowel; and various other devices have been advocated to insure contact and union. But the main fact has, in most of these speculations, been entirely lost sight of; viz. that if the margins of each end of the divided bowel are but accurately adjusted to each other, and maintained in perfect apposition by sutures (whether the mucous or serous surfaces be made to touch), the divided portions are united at first, *not* by any act of union *between* the surfaces in contact, but by the effusion of fibrine around the once separated, but now approximated and contiguous extremities; and thus does this fibrine not only maintain their conjunction, but it also, by adhesions, fixes the injured portion of bowel to the adjacent surfaces of peritonæum, either visceral or parietal. When the Surgeon finds that a wound of the bowel amounts to entire division of the gut, he may at once fix the divided portions in contact with each other, with silk sutures; and then return the intestine into the abdomen. Or else he should lose no time in securing the edges of the wound of the intestine to the margin of the external one, so as to facilitate the formation of adhesions between the adjacent surfaces of both, and to prevent the possibility of any fæculent contents escaping into the peritoneal cavity. In complete division of the bowel, such treatment is to be preferred. Its effect is necessarily the establishment of an artificial anus in the first instance.* The following points should guide us in the choice between these two methods of dealing with an entire division of the intestine: that, if the division be caused by a clean sharp instrument, the extremities may be brought entirely together, with sutures; but if the separation be the result of an irregular lacerated wound, as from gun-shot, &c., then we should not hesitate to fix the edges to the external wound, and risk the chance of an artificial anus.

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* Mr. Travers has proved, by experiment, that "the absolute contact of the everted surfaces" is requisite, to avoid the risk of abdominal effusion.

If the divided extremities be brought together by sutures, and replaced in the abdomen, the injured portion of bowel need not be retained by ligature at the external wound, for, as a general rule, the one has been found to remain in contact with the other: and when perfect occlusion of the cut surfaces has not occurred, but some escape of the contents of the bowel taken place, that effusion has passed through the external wound; the adhesions within have prevented internal extravasation.

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* The treatment of artificial anus forms a separate section.

Let us now consider by what steps reparation occurs in a wound of the intestine, subsequent to the application of ligature or sutures. The results of all recorded experiments prove *this:* that there rapidly takes place an effusion of fibrine on the surface of the peritonæum around the wound. This effused fibrine soon agglutinates the wounded portion of intestine to the adjacent surface of peritonæum, and thus covers in the suture, and shuts it out from the general cavity of the peritonæum. The ligature or suture applied to the wound, in the mean time has commenced to destroy the small portion of bowel which is surrounded by the silk,—that portion of the gut is either killed by the ligature, or all the coats ulcerate through, in consequence of the action of the suture. The death of the part in the first, or the ulceration of the part in the second instance, are processes which travel from without *towards* the *interior* of the bowel. *Exteriorly*, either process is limited by the effused lymph. *Internally*, there is nothing to stay either one or the other. Either is continued until death, or the act of destruction (ulceration), is completed. The mucous lining of the intestine is included with the other coats in the grasp of the silk ligature or suture; and when the last remaining portion of the wall has been cut through by the action of one or the other, the knotted silk drops into the bowel, and passes away with its contents.

Thus much, therefore, is evident; first, that, soon after the application of a ligature or suture to any portion of intestine, fibrine is effused on its surface, and the ligature becomes thus shut out from the peritoneal sac: secondly, the ligature as soon commences to destroy that portion of bowel which is surrounded by the silk: thirdly, that, as the mucous membrane (forming one of the layers of that portion) dies, or ulcerates, it opens inwards a path of escape for the ligature, which is only complete when each coat of the bit of intestine is entirely cut through: and, fourthly, that this path opens *into* the bowel; not *from* it.

Mr. Travers tied a ligature round the duodenum of a dog, so as completely to obstruct the intestine. This was returned into the abdomen, and the wound closed. On the fifth day, the dog passed a copious stool; and he recovered entirely from all effects of the ligature. He was killed on the fifteenth day. The wound of the duodenum, produced by the ligature, was entirely closed. Omentum was adherent to the surface at the part to which the ligature had been applied. The gut, when laid open, was marked by a transverse fissure at the seat of ligature. The ligature had passed away entirely.* The wound is thus closed; the ligature has escaped; and the injured portion of bowel is adherent to the abdominal wall, or some adjacent viscera. What has become of the everted edges of the mucous membrane? Are the surfaces united, face to face, or so inverted as to allow the wounded intestine to unite at its edges? Mr. Travers was evidently not satisfied on this point. He observes, "The opposed villous surfaces, so far as my observation goes, neither adhere nor become consolidated by granulation; so that the interstice marking the division, internally, is probably never obliterated."

Observation of wounds in mucous membranes of other parts does not allow the author to agree with these remarks; nor does Mr. Travers appear to have had *positive* evidence, to enable him to decide unhesitatingly that such union *could* not, or *did* not, occur. Drs. Gross and Peterquin arrived at the conclusion that union *does* occur between the edges of the divided mucous membrane, and that the former position of the gap, after a time, is only indicated by a line of cicatrix.

The treatment subsequent to the replacement of the injured intestine should be similar to that sketched out in our observations on wounds of the abdomen. Punctures or wounds of the intestine must always be considered as very dangerous in their character, and are very frequently fatal in their result; and an entire division of the bowel is generally fatal.

Wounds of the stomach, with protrusion, are much more rare than wounds of the intestines. The treatment of wounds of the stomach should be guided by principles similar to those which apply to wounds of intestines: though, if the wound be large, it would be best to secure its edges to the external one, rather than apply sutures and simply return the protruded portion into the abdomen. A large wound so treated would, for a time at least, be followed by gastric fistula.

Wounds of the viscera which occur in penetrating wounds through the abdominal wall, may be said to be decidedly more formidable than those just considered.

Punctured wounds of the stomach or intestines, if small, are not necessarily followed by effusion. If the stomach be empty, in all probability effusion will not take place. Inflammation rapidly causes the aperture to adhere to some adjacent surface of peritonæum, and thus occludes the opening on the peritoneal surface. If the stomach be full, extravasation of its contents into the cavity of the peritonæum is apt to occur; but this complication need not necessarily take place, for vomiting rapidly supervenes upon wounds of the stomach, and soon empties it of its contents; blood would be mixed with the fluid thrown up, or large quantities of blood alone vomited. With escape of the contents into the peritonæum, there would follow all the most severe symptoms described in cases of rupture of the stomach. If the wound be across the lesser or greater curvature, very abundant hæmorrhage will be present, either into the stomach, or into the peritoneal sac. The danger in a wound of the stomach is greatly lessened when its contents are observed to escape externally; and though, in such cases, life hangs by a thread, instances have occurred of such wounds terminating in gastric fistulæ, from union of the margins of the internal with the external opening; so that the patient survived the accident.

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* Travers on *Injuries of Intestines*, p. 99.

Dr. Marcet has several times succeeded in establishing gastric fistulæ, by opening the abdomen of dogs, and drawing the surface of the stomach to the wound, and there fixing the coats with sutures; an opening then made into the stomach allowed a silver tube to be introduced and made fast in the opening. The care with which the operation is performed in a great measure influences the recovery of the animal; it is requisite not to disturb the parts much, and not to allow the escape of the least portion of the contents of the stomach into the peritonæum; otherwise, the animal dies. Dr. Marcet states, that it requires a strong, hardy animal to recover from this operation; and generally, when recovery has taken place, the animal does not appear to be the worse for the fistula: escape of the gastric fluid is controlled by a cork inserted into the silver tube. The latter is fastened into the wound, most effectually, by an ingenious method adopted by Dr. Marcet. Two dogs, in each of whose stomachs a fistula had been formed, survived more than twelve months, and appeared healthy and in good condition.

It will always be difficult to determine whether the stomach is implicated in a penetrating wound, unless there be escape of the contents through the external wound, or there be blood vomited. The treatment, therefore, must depend on the symptoms. No interference should be permitted with the external wound, if the contents are passing through it. The stomach should be kept empty, and the patient nourished entirely by enemata of beef-tea or soup. If there be no evidence of escape of the contents, but it be suspected that the latter have passed into the peritonæum, as evidenced by the severity of pain and other symptoms, no treatment is available to save life; and, in such a case, we have only to endeavour to mitigate suffering.

Punctured wounds of the intestine from penetration of the abdominal wall by a sharp intrument, are not so serious as similar wounds of the stomach. Such small wounds do not generally permit extravasation of the contents, as the opening is soon plugged by the mucous membrane. But larger wounds are much more fatal, unless the internal wound be in apposition with the external one, so that the contents of the bowel may escape externally. In such a case, the wound should not be interfered with. Artificial anus for a time may be established, and so far immediate danger is lessened, if not removed. It is impossible to determine what portion of bowel may have been wounded in a penetrating wound of the belly, or whether several portions are not implicated in the injury. The external wound is no guide to us in this respect. If the wound of the intestine be very small, there may occur but very slight symptoms to indicate its existence; but if large, or if there be several wounds, then blood will probably be observed in the motions; and pain, vomiting, and other severe symptoms, will soon indicate the alarming character of the local damage. As a rule, wounds of the small intestine are more serious, *ceteris paribus*, than wounds of the large. In a wound of the latter, the escape of the contents externally is more probable, and more ready, on account of the movements of the bowel being much limited, and the aperture consequently more fixed. The escape of fæcal matter into the peritonæum depends much on the state of the bowel; even with a large wound in an empty intestine, Mr. Travers found that extravasation did not necessarily occur at the time of the injury. With regard to the treatment of wounds of the intestine within the abdomen, whether punctured, or incised, or lacerated (gun-shot), we need say little more than that great attention is to be paid to the external wound. Any hope of recovery rests in the chances that, if the wound of the intestine be small, no escape of contents will have occurred; or if the wound be large, that the escape will be external. If the first condition be suspected, we need only simply dress the external wound. If the second be manifest, the external wound *must* be left open,—it is the safety-valve of life in such an injury,—and its premature closure might most unexpectedly and rapidly cause the death of the patient.

Wounds of the liver, spleen, and kidney are dangerous, in proportion to the amount of hæmorrhage, rather than from other cirumstances. As it would be impossible to determine the fact of njury of either the liver or spleen in a punctured wound, we need ot enter further into the question, beyond stating thus much, that, f *hæmorrhage* be not fatal, there is no reason the patient should ot recover. Hæmorrhage will be indicated by collapse, &c.

Wounds of the kidney or bladder will be suspected from blood in he urine. When the latter viscus is injured, as a rule, the case will prove fatal if urine has entered the sac of the peritonæum. See INJURIES OF THE PELVIS.

In concluding his remarks on this portion of the subject, which mbraces the consideration of wounds of the viscera, the effects of hose wounds, and their treatment, the author ventures to hope that he reader will derive some assistance from the following general ummary—a kind of index of results attendant upon these injuries:

1. That a rupture of stomach or intestine, *without external wound*, s a fatal lesion; more fatal than when lesion of either viscus occurs *with external wound.*

2. That when rupture of liver or spleen is fatal, death is generally he result of hæmorrhage. Rupture of the gall-bladder is always fatal.

3. That when rupture of the kidney proves fatal, death, when ccurring early, is the result of hæmorrhage; when occurring later, s the result of extravasation of urine.

4. That recovery from rupture of the liver, spleen, or kidney is not improbable nor uncommon.

5. That a wound of the peritonæum, without bruise or laceration f tissues, is by no means necessarily fatal.

6. That a protrusion of intestine, or portion of other viscera, if he protruded part be not bruised, nor long exposed, need not necessarily prove fatal.

7. That a wound of protruded intestine or stomach, if small, hould be secured by ligature—if large, by sutures; and the protruded viscus returned into the abdomen. The former lesion may erminate in recovery; "but wounds amounting to direct division f the canal are irreparable,"* unless artificial anus be established.

8. That a punctured wound of viscera is more dangerous than a wound with protrusion—less dangerous than rupture without external wound; that the danger is in proportion to the size of the internal wound; and that an artificial anus offers the best prospect f recovery when the wound is extensive.

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* Travers, p. 133.

Fistula of the Stomach.

Hennen, in his work on *Military Surgery*, observes, that "wounds of the stomach are extremely dangerous, though not mortal;" and he adds, that, according to M. Percy's observations, only four or five out of twenty recover. We have already alluded to the prospect of recovery after a wound of the stomach. Recovery may, in the first instance, occur from immediate blocking up of the internal wound, and union of the external one by first intention; or recovery may be qualified to this extent, that the two wounds become soon united to each other by their margins, but leave an opening through the walls of the stomach and the external parts. An escape of the contents of the stomach takes place through this opening, which may continue stationary for an indefinite time; such an opening constitutes a *gastric fistula*—fistula ventriculi externa; and we now propose to consider its conditions and treatment.

That the occurrence of a gastric fistula, or its persistence, is not incompatible with life, or even health, is a fact so satisfactorily authenticated, that it requires no confirmation on our part to establish it. We shall have to refer to cases which afford ample and conclusive evidence, not only of the formation, but the duration of these fistulæ over many years. A fistula of the stomach occurs on the escape of its contents externally, through a lacerated or incised or punctured wound, after the internal and external wounds have become blended by their margins into one opening; or the fistula may be the result of ulceration of the stomach, followed by adhesion of the opposed peritoneal surfaces, and ultimate perforation of the abdominal wall; or the consequence of a foreign body making its way through the visceral and abdominal parietes; or the result of abscess; or the effect of malignant ulceration.

When the wound, which allows the escape of fluid and food from the stomach, has become clean and healthy, granulation slowly produces a continuous smooth cicatrix between the outer skin and inner mucous surface of the stomach. This is, however, generally rather a tedious process, the cicatrisation being frequently interrupted by painful excoriation and ulceration, caused by the excessively irritating quality of the fluids constantly oozing out. But for a time the opening gradually contracts. If originally small, it may close in the course of a few weeks; if not small, it will probably remain open many months;—it may remain fistulous for many years.

The first difficulty with which the Surgeon most probably will have to contend, will be the escape of the food; the second, will be the prolapse of the mucous membrane. The escape of the food will depend, in amount, on the size of the opening; the loss may be so great, that sustenance becomes a question of moment; and then recourse must be had to nourishing enemata. It is never desirable to plug the fistula to prevent escape of food, for the action of the plug is invariably to dilate the opening. A compress over the opening is the best application for the purpose of moderating the escape; and sometimes this treatment will succeed almost entirely in effecting the desired object.

The prolapse of the mucous membrane will depend very much on the size of the opening, as also somewhat on the part of the stomach implicated in the fistula. If the opening be in the upper portion of the large extremity, the prolapse will probably be but slight; whereas if the opening be towards the lower part, or pyloric extremity, the protrusion will be more troublesome. However, prolapse of the mucous membrane does not generally offer any difficulty in treatment; it is usually readily returned, but requires slight pressure to keep it from escaping through the fistula.

The following well-known case so well illustrates the points above alluded to, that we cannot help introducing it shortly, for that purpose. Alexis St.-Martin, aged eighteen, was wounded by a musket on the left side, when about a yard from the muzzle. The shot blew off the integuments and muscles, to the size of the hand, fractured and carried away the anterior half of the sixth rib, fractured the fifth rib, lacerated the lower part of the left lung and the diaphragm, and perforated the stomach. On the sloughs separating, a perforation large enough to admit the middle finger was observed in the stomach (besides other injuries, which do not bear on this question). *For seventeen days every thing swallowed passed out through the wound;* and the patient was kept alive chiefly by nourishing injections. At every dressing of the wound, the contents of the stomach flowed out; its coats frequently became everted, or protruded so far as to equal in size a hen's egg, but were easily returned. After the fourth week the lad's health was quite restored. For some months the food could be retained only by wearing a compress and bandage; then a small fold or doubling of the villous coat began to appear, which gradually increased till it filled the aperture and acted as a valve, while it admitted of being pushed back by the finger from without. The wound was inflicted in June 1822, and St.-Martin was alive in March 1833. The orifice of the wound was then in the same state as in 1824, being about two inches and a half in circumference. When the stomach was entirely empty, the valve was generally forced out through the orifice, together with a portion of the mucous membrane equal in bulk to a hen's egg. After he had slept for a few hours on the left side, the protruded portion became so much larger as to spread over the neighbouring integuments five or six inches in circumference, and fairly exhibited the natural rugæ, villous membrane, and mucous coat lining the gastric cavity.*

In the *Med.-Chir. Trans.* vol. xli., a case is related by Dr. Murchison, of a woman aged thirty-four, in whom a fistula was occasioned by the continued pressure of a copper coin over the epigastric region; ulceration was set up; and the pressure, constantly applied to the surface of the ulcer, at last effected a communication from without into the cavity of the stomach. Dr. Murchison has added to the particulars of this case a short table of cases of gastric fistulæ, many of them the result of disease commencing from within.

The treatment of a gastric fistula should, in the early days of its occurrence, be most simple. The parts should be kept scrupulously clean, and the compress and bandage and other dressings frequently changed; lint, moistened with tepid water, is the simplest and most cleanly dressing, and should be used as soon as the wound has commenced to granulate; and as long as there is any tendency to contraction nature should be permitted to pursue her course unmolested. Frequently, such fistulæ will close without our interference.

When all further prospect of closure is at an end, when contraction of the orifice of the fistula appears to have been carried to the utmost, and the fistula indicates that, without some surgical assistance, it may remain patulous for the period of the patient's life, then it becomes the duty of the Surgeon to endeavour to assist in the closure of the orifice; otherwise the fistula will last for years. Richerand mentions one extending over a period of nine years. In Haller's *Dissertations* two cases are recorded, one by Etmuller, in which the fistula continued open for ten years; another by Wenker, in which it remained patulous for twenty-seven years. Under such prospects the presence of a gastric fistula becomes a grave evil, and all practicable efforts should be made to relieve the patient. The prospect of closure held out by a plastic operation is such, that we may attempt by repeated operations to close the orifice, even should the first prove unsuccessful. Dr. Middeldorpff* has related a case, in which he lately succeeded in almost entirely closing a gastric fistula (apparently the result of some ulcerative process in the stomach), which had existed some five years. A flap of skin was brought up from the lower extremity of the opening, and fixed to its edges by sutures. The whole of the surfaces united, with the exception of a point the size of half a pin's head. As this fistula happened to be situated between the cartilages of the sixth and seventh ribs on the left side, it was in an unfavourable position for contraction, and in an equally unfavourable part for the success of any attempts made to close it. The almost complete success of Dr. Middeldorpff is very encouraging, under the circumstances of the case he has related; and should lead us to anticipate complete relief from a similar operation, were the fistula situated below the cartilages of the ribs, and in a situation in which the tissues yield more readily. Sometimes one or two sinuses burrow round an abdominal fistula; should such exist, they should be laid open before the attempt is made to close the principal artificial aperture.

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* For the further interesting particulars of this case, we must refer our readers to Dr. Beaumont's *Experiments and Observations on the Gastric Juice, and the Physiology of Digestion.*

Fistulæ of the gall-bladder may be the result of abscess caused by the presence of a gall-stone. Such cases are very rare, nor do they require much more than a passing notice. Before such a fistula can form, the patient must have had pretty marked evidence of previous mischief in the neighbourhood of the liver and gall-bladder, with constitutional disturbance of no slight character. The treatment, as far as the Surgeon is concerned, should be, to give exit to matter as soon as local evidence of its collection is in any degree marked, or its existence suspected. Should a gall-stone be lodged in the abscess, or present at the opening, some degree of caution is necessary in interfering with it; but the sooner it can be removed without risk, the earlier will be the relief afforded to the patient, and the sooner will the parts commence to recover. There may remain a fistula with bile escaping from it for some time, but unless there be some marked reason for surgical interference, it were better to leave the parts to contract of themselves.

ARTIFICIAL ANUS.

Artificial anus "generally results from loss of substance consequent on mortification of the bowel in strangulated hernia, but may be the consequence of penetrating wounds, or of ulceration of the canal from internal or external causes."* Whether artificial anus be the result of accident or disease, the conditions which the opening may assume, or the treatment to be adopted for its relief, in either case cannot vary to any great extent. We therefore propose to consider the evil under both aspects.

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* *Brit. and For. Med.-Chir. Rev.* Oct. 1860, p. 545, from the *Wien. Wochenschrift*, Nos. 3-6.

As in lesions of the stomach, so in fistulous apertures of the intestine, there may be a small or large permanent opening, established by the union of the sides of the internal wound with the circumference of the wound in the abdominal parietes. But the size of the fistulous orifice, through which escape of fæculent fluid takes place, will depend entirely on the amount of destruction of the intestinal wall, not at all on the original size of the external wound. In proportion to the loss of the former, there will be experienced a difficulty in closing the latter, and in proportion to the distance of the common orifice from the pylorus will the chance of immediately saving or of prolonging life be increased. For the purpose of considering the general features of an artificial anus in its early condition, we will assume that, whether the fistula be the result of wound, or mortified bowel, or other cause, the orifice in the bowel has become fixed to the margins of the external aperture; that all sloughs caused by injury or disease have become separated; and that there is, at the opening, a continuous surface from the integument without to the bowel within. What characteristics may we expect to find about such an opening? Usually the aperture will be more or less round, but it may be oblong and irregular. The smaller it is, as a rule, the more circular will be its shape. The margin will seldom present a smooth or healed condition, but will often be somewhat puckered, and more often excoriated and bleeding. The skin surrounding the aperture will generally be much irritated, sometimes quite sore, and often very sensitive or exquisitely painful; all which is the result of the irritating matters escaping from the gut and running over the integuments round the fistula. As the orifice of the fistula contracts, the surrounding skin is thrown into slight ridges; the furrows between which become sometimes deeply ulcerated. The condition of the orifice itself will depend much on the size of the opening; if small, the mucous membrane will generally be observed at the bottom of the orifice, and a constant oozing of fæculent matter and intestinal mucus will persist as long as the orifice remains.

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* Lawrence *on Hernia*, p. 379.

If the orifice is large, some amount of prolapse will constantly occur through the fistula; but when the intestine retains its proper position within the abdomen, from the posterior wall of the fistula will be observed a fold of membrane — its thin edge projecting towards the outlet. If the destruction of the bowel has been extensive; for instance, if the bowel has been divided, and the divided extremities have become attached to the external wound; or if three-fourths of the wall of the intestine has been lost by slough, or shot away, and artificial anus has been formed, then we shall be able to observe distinctly the upper and lower orifices of the bowel, and between them the fold of mucous membrane will be seen projecting almost to the level of the external outlet; in fact, so as to form a distinct and prominent partition which extends from behind forwards, between the openings of the upper and lower portions of the gut. In proportion to the projection of this fold into the wound, so is the obstruction to the passage of the contents from one opening to the other. The fold may even, and often does, project sufficiently to lap over the lower opening, and then will conduct the whole of the contents of the upper division of the bowel directly outwards through the artificial anus. The fold, to which we have now drawn attention, constitutes an important feature in the ultimate condition and in the treatment of artificial anus; to this fact we shall refer presently.

Such, then, are the general external characteristics of artificial anus. We have now to examine the conditions, within the abdomen, of the portion of bowel implicated in the opening. If we trace a convolution of the upper portion of the intestine towards such an aperture, on approaching the latter, the bowel will be observed, within the last few inches, to form an angle more or less acute with the portion of intestine which forms the commencement of the lower division. According to the amount of destruction of the bowel, and the prominence of the fold of mucous membrane within the wound, will be the acuteness of the internal angle; and if the angle be very acute, in consequence of extensive destruction, the portions of bowel forming the angle will lie more or less side by side, or sometimes cross each other, as they approach the fistula. The serous surfaces of these opposed portions are not generally adherent to each other. Intestinal convolutions may dip down between them, and even push forwards a serous sac into the artificial opening. This is an important fact,—viz. that the mass of intestine within the abdomen is only protected externally, at the artificial opening, by the thickness of the wall of the adherent bowel. The serous surface of the intestine, where the latter is adherent to the abdominal wall, is continuous with the parietal peritonæum all round the false opening; for the two serous surfaces, parietal and visceral, have become adherent to each other, either previous to the sloughing of the bowel in a hernia, or subsequent to the wound of the intestine in an injury. The adhesions, which unite the intestinal to the external orifice, occur first on the peritoneal face of each opening, and are at first slight, but subsequently become more firm as they become vitalised. But the extent of such adhesions is never broad, nor capable of offering much resistance to the pressure of the viscera within. Mr. Lawrence justly observes, "the abdominal cavity is protected at the margin of the opening by a feeble barrier; the extent of the adhesions being only from half a line to a line, sometimes, but rarely, reaching to half an inch."* As the membrane covering the bowel attached to the orifice is thus continuous with the parietal peritonæum within, so the membrane lining the bowel is continuous with the cuticle which surrounds the artificial anus without.

Such, then, are the general and early conditions usually found in a case of artificial anus: certain variations may be met with, dependent on locality. In an artificial anus, the result of an accidental wound of the large intestine, or the consequence of an opening made into the colon in the lumbar region for the relief of obstructed bowel, the probability is, that no fold of mucous membrane will exist, such as is observed when any considerable portion of the small intestine has been destroyed. When the opening is high up and implicates the jejunum, the fluids which escape are less offensive than when the opening exists in the lower part of the small intestine. When the opening is in the large bowel, the discharge often consists of hard fæculent masses, and is always of the character of that passed naturally from the rectum. Within also, when the large bowel is implicated, there need be little disturbance of the natural position of the bowel; there need be no angle formed by the upper and lower portions of the bowel fixed at the aperture; and there need be no adhesions of the serous surfaces to secure the wounded intestine to the abdominal wall, as the bowel may have been opened external to the serous sac.

Certain changes will occur in an artificial anus, as time passes by. If the opening was originally small in the intestine, the external orifice will gradually contract, the escape of the contents will diminish in proportion to the contraction, and, in some few weeks or months, the aperture may close. If the aperture in the intestine was originally large, the artificial opening will gradually become less, up to a certain point, and then remain stationary in size. The edges will often become thick and callous, and will also occasionally become puckered inwards; at the same time, the fold of membrane which projects from within, becomes gradually directed away from the orifice which leads into the upper portion of the bowel; for the stream of fæculent matter acts constantly against the corresponding surface of this projection, and inclines it towards the orifice of the lower portion, sometimes so as to close it completely, and thus effectually prevents the passage of fæces from the upper into the lower portion of the bowel. In proportion to the extent and projection forwards of this fold, will the passage of fæculent fluid or food across the area of the artificial anus, and through the lower portion of the intestinal canal, be diminished; the fold acts as a dam across the natural passage, and directs the stream through the new aperture, to be discharged externally. And as the facility of communication from one to the other becomes less, so the orifice of the lower portion contracts, while that of the upper portion often becomes dilated and thickened. As the artificial orifice is not guarded by a sphincter-muscle, the escape of the contents is constant, and is beyond the control of all voluntary efforts or desire. The patient's health will become much deteriorated if the small intestine is open far above the ileo-cæcal valve; nutrition is then but imperfectly carried on. The patient suffers greatly from the excoriation caused by the acridity of the discharge, the constant moisture of the skin, and the frequent necessity to cleanse the wound; so that with a slight attack of diarrhœa, or other exhausting ailment, one in such a condition rapidly sinks. "The prospect of regaining and preserving health and strength," observes Mr. Lawrence, "when the continuity of the intestine cannot be restored, depends entirely on the situation of the unnatural opening; is greater in proportion as that is nearer to the inferior end of the canal, and smaller as it approximates to the stomach."

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* Lawrence *on Hernia*, p. 380.

One of the most marked effects of an artificial anus, whenever the fæculent fluids escape entirely through it, is that the lower portion of the bowel, *i. e.* all below the aperture, becomes contracted; and in time, so much so, as hardly to be recognisable as the intestine of an adult. The tube is, however, rarely obliterated. Dupuytren mentions a case which occurred in the Val-de-Grâce, in Paris, observed by M. Begin, and in which the lower portion of the bowel was obliterated, and formed a solid cord. The portion of intestine forming the artificial anus was the transverse colon. The patient was eighty years of age when he died, and he had suffered from artificial anus for forty years. The lower portion of the rectum was not quite obliterated, but next to the artificial orifice, no trace of canal was to be found.*

In an artificial anus there is a constant tendency towards prolapsus of the bowel. There may also occur a hernial protrusion behind or through the wall of the adherent intestine, or between it and the external wound. This is not frequent. Prolapsus usually takes place through the orifice of the upper portion, and is a common occurrence to a slight extent. Generally the protruded bowel is readily returned, and can then be retained by gentle pressure secured by a bandage or truss. But prolapsus may be very extensive, and may even prove fatal. A patient operated on by the author, in the autumn of 1859, for strangulated femoral hernia, was found, when the sac was opened, to have mortification of the greater portion of the circumference of a piece of small intestine. The bowel was cut open where dead, and the protruded intestine left in the wound. An artificial anus was thus established; and though the patient was greatly reduced, and extremely ill for many days subsequently, she recovered sufficiently to quit the hospital about three months after the operation. The artificial anus was then rather more contracted than at first, but almost all the fæces passed externally through the opening. She gradually gained strength, and recovered sufficiently to be able to do a little work. About six months after she left the hospital, one afternoon while lifting some furniture when cleaning her room, she felt something suddenly wrong in the region of the artificial anus, and immediately experienced great pain. She was only able to get on to the bed, and, being quite alone, was unable to procure assistance. She now perceived that there was a large protrusion at the artificial anus. In the evening her husband returned home, but so drunk that he could not be made to understand the urgency of her sufferings, and would not consent to any medical advice being procured. The poor woman passed the night in great suffering, and in the morning the husband, having returned to his senses, called Dr. Martyn of Brompton to see her. Hearing the particulars of her history, Dr. Martyn asked the author to visit her. A large mass of prolapsed bowel, some three feet in length, was found lying external to the artificial opening. The mucous membrane was dark-coloured and almost black from congestion, and blood was oozing from its surface generally. The protruded portion of bowel was thrown into several convolutions, was greatly distended and much solidified, and excessively tender when touched. She was admitted into St. George's Hospital, where, after consultation with Mr. Cutler, the author attempted the reduction of this really frightful-looking mass of prolapsed bowel. While attempts at reduction were being made with extreme care and much gentleness, a quantity of intestine (covered with peritonæum) was observed to escape suddenly from the abdomen, by the side of the bowel already prolapsed and covered with mucous membrane. A double complication now existed. It may be somewhat difficult to appreciate the exact peculiarities of this complication without an illustration in drawing; but, to render the case more clear, its various stages and conditions are shortly recapitulated. Previous to the occurrence of the prolapsus, the original openings in the intestine and the abdominal wall were adherent to each other by their opposed margins, so that one common opening, the artificial anus, was the result; the visceral and parietal peritonæum being continuous with each other around the internal aspect of the opening. Through this common opening, a portion of the upper bowel became prolapsed, and projected externally. This projection was the mass covered with mucous membrane, which was seen in the first instance. The pressure exerted by the protrusion of so large a mass of bowel on the margins of the artificial anus, caused the adhesions between the two original wounds to give way; consequently the opening in the wall of the bowel was no longer attached to the abdominal opening; and the latter now communicated directly with the interior of the peritonæum. Through this opening, leading into the cavity of the peritonæum, the portion of bowel covered with peritonæum passed out: but there had already escaped, through the same external opening, the prolapsed bowel. The following condition of parts, therefore, was found at the aperture in the abdominal wall: a mass of bowel (which had become first prolapsed through an opening in its wall) projected externally, covered with mucous membrane, having escaped through the parietal aperture; and by the side of this portion of bowel, there projected a mass of intestine covered with peritonæum, having escaped externally through the same parietal orifice.

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* *Dictionnaire de Méd. et Chir. pratiques,* tom. iii. p. 133.

The prolapsus was readily reduced, by drawing upon the portion of bowel which had last escaped. The latter was traced to the point where the invagination commenced, and was then gently pulled until the invaginated portion was entirely unfolded. The intestine was then easily returned into the abdomen, and the original wound of the bowel secured to the margins of the external opening with sutures. The poor woman was so much exhausted by her prolonged sufferings, that she expired the following morning. The portion of intestine below the wound was found very much contracted, and free from fæculent matter.

When hernial protrusions occur through an artificial anus, the coverings of the hernia will be solely formed by the coats of the adherent intestine, mucous membrane outside, and peritonæum within; but should the hernial protrusion be other than small, we must anticipate some separation of the adhesions which attach the orifice of the bowel to the abdominal wall, as occurred in the case last described. In such a case, the pressure exerted on the intestine round the orifice would be very considerable, and the protruded sac might even be ruptured from this cause.

The treatment of artifical anus depends much on the features of each case. When the opening is small, we need do little more than require the patient to be kept as clean as the circumstances of the case will permit, and meanwhile endeavour to restrain the escape of fæces or food through the orifice, by the application of gentle pressure. Closure of the opening will frequently occur, in such a case, without any further interference on the part of the Surgeon. A young woman, operated on for strangulated femoral hernia, by Mr. Johnson in St. George's Hospital, recovered with an artificial anus in the left groin. By degrees the opening gradually contracted; once or twice it appeared closed; again opened; and, some eight months after the operation, became entirely healed.

If the opening shows no tendency to close, and the patient objects to operative interference, the inconvenience can be but little mitigated by external measures. Pressure offers the best prospect of regulating somewhat the escape of the fæces. Various arrangements have been adopted to alleviate the distress of the patient; receptacles of different shapes and materials have been so fixed to the body, as to cover-in the orifice of the bowel and receive its contents as they pass out. But though much ingenuity has been exercised upon the construction and adaptation of such appliances, at best they have been found but of trifling service. Mr. Lawrence recommends the constant use of a truss to prevent prolapsus; and the author's experience induces him strongly to advocate the importance of this recommendation. A compress of linen placed in the opening, with a larger pad over it, and a truss applied over the whole, will in a great measure restrain the contents, as well as prevent the protrusion of the bowel.

The relief or closure of artificial anus has been attempted by surgical interference. Before alluding to the measures adopted for, what is termed, *a radical cure*, we must shortly refer again to the condition of an artificial anus which has baffled the Surgeon's attempt to close it by pressure. In such a case, the orifice of the upper portion of the bowel will be well marked, and the fold of mucous membrane (*éperon*, as it is termed by French authors) will be more or less prominent. If a finger can be passed into the opening of the upper portion, and another into that of the lower portion of the bowel, and the ends of the fingers be approximated, they will only be separated at these two points by the opposed walls of the intestine; but for an instrument to pass through from one point to the other, the peritonæum would have to be necessarily twice perforated; for usually no adhesions exist between the serous surfaces corresponding to these points. The éperon, or fold, at its *free* margin, consists of two layers of mucous membrane; but immediately behind the free border, will be formed of the muscular and serous layers of the bowel.

In order to push back the prominent edge of the éperon, Dessault passed a tent of linen three inches in length into the intestine, through an artificial anus in a patient under his care, and covered the opening with a compress and bandage. This tent he proposed to remove twice a day, to allow the evacuation of the fæces; but he found that, after some noise and pain in the bowels, some fluid was discharged through the rectum, and during three following days several motions were passed. The tent was discontinued on the eighth day, and the opening was closed by compress, and supported by a truss. The case quickly recovered. It is stated that nothing had passed through the rectum in this case, from the time of the receipt of the wound which produced the artificial anus, until the treatment alluded to was adopted by Dessault, a period of four years. This method of treatment can only be recommended for trial in cases in which the internal angle of the bowel is not very acute, and consequently when the éperon is not very prominent. In fact, in such cases, with proper care and simple pressure, time will most probably insure permanent obliteration of the artificial opening.

It will now be evident that the chief obstacles to the closure of an artifical anus, which defies the usual palliative treatment, arise from the loss of intestinal wall, the consequent acuteness of the angle at which the portions of the intestine meet at the aperture, and the unavoidable prominence of the éperon or fold—conditions which most effectually interfere with the passage of fæces into the lower division of the bowel. If the serous surfaces of the two portions of the intestine, within a few inches of the opening, were adherent to each other, nothing would appear more justifiable or easier than to divide the éperon some distance inwards, commencing at its free margin; and then this process of treatment would probably be as safe as it would be easy. A direct and free communication between the upper and lower portions of the bowel would be thus immediately established; the éperon would be destroyed; and fæces would flow along the natural channel more readily than escape externally, especially if pressure was applied over the opening. But it has been explained that the éperon is formed merely of a duplication of the mesenteric or attached border of the wounded bowel; the artificial aperture would, in most cases, be situated in some portion of the former free surface. The duplication would therefore consist, within the intestine, of two layers of mucous membrane; within the abdomen, of two layers of serous membrane, and intermediately of the muscular and cellular coats of bowel. To divide this éperon to a sufficient extent to relieve the obstruction it produces, would necessitate cutting into the cavity of the peritonæum; for we should have to cut through the serous surfaces of the opposed portions of bowel. Even a further risk would have to be encountered. There might be intestinal convolutions lying between those two surfaces of bowel, which must necessarily be divided in order to secure sufficient increase of space in the canal; therefore an instrument carried across the space occupied by such convolutions might seriously injure any portion of viscera there interposed.

To Dupuytren* we are indebted for originating a method of treatment which, perhaps of all others, holds out the prospect of dividing the éperon, with as little amount of risk to life as can possibly be obtained in so formidable an undertaking. But the fact must be fully appreciated, that any interference with this éperon, or projecting fold, must always necessarily be attended with considerable risk of peritonitis, and danger to life.

"Restoration is seldom accomplished by the united efforts of nature and art," writes Dupuytren, "when the loss extends to four-fifths, or to the entire circumference of the intestine, with or without the mesentery, whatever may be the extent of the mischief in length. The destruction of the bowel, the contraction and change of direction in the tube, the projection of the ridge and septum, are here carried to the greatest extent, and constitute an insuperable obstacle to the transmission of the intestinal contents in their natural course. If compression be employed with sufficient exactness to prevent escape of fæces, symptoms of strangulation are produced, such as colic, nausea, vomiting, hiccup."

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* *Mémoires de l'Académie de Médecine,* tom. i. 1828.

Dupuytren saw that, if, without opening into the cavity of the peritonæum, he could in extreme cases destroy the éperon by any means which would facilitate the passage of fæces in their natural course, the probable result would be the closure of the artificial anus; but that, without the removal of the éperon, there was no prospect of relief. He determined to make the attempt, to establish a direct communication between the upper and lower portions of the gut by destroying the septum. After one or two attempts to effect this by pressure and ligature, he ultimately made use of an instrument, which he termed an *entérotôme.* By the application of this instrument, he considered that the projecting ridge and septum might be destroyed in a short period. It is here only requisite to state, that this instrument is so constructed that it somewhat resembles a pair of forceps, the blades of which can be separated from each other, or, when adjusted to the septum, can be approximated by the action of a screw, so closely as to be firmly fixed on the part embraced in their grasp. One blade, being grooved, receives the edge of the other, when the instrument is closed; so that any intervening tissue, thus firmly grasped, is so effectually compressed as to be destroyed in a very short time. When it has been decided to use this instrument, "the first step is to find the two openings of the intestine, and to determine accurately the direction taken by the corresponding portions of the canal. Usually this is the longest and most difficult part of the proceeding. The discharge of the contents generally points out to us, without much trouble, the orifice and course of the upper end. But greater difficulty is experienced in discovering the lower. When the position of the openings and the course of the two portions of bowel have been ascertained, one branch of the entérotôme is introduced into one end of the bowel, and, according to circumstances, carried to the depth of one or more inches; the other branch is placed to a corresponding depth in the other end."* The blades are then adjusted and firmly fixed by the action of the screw. Dupuytren recommended that the pressure should at once be carried to such an extent as to extinguish circulation and life in the part immediately; and, to prevent circulation being reëstablished at any point, he advised the pressure to be increased every second day.

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* Dupuytren, op. cit.

The application of the instrument does not usually occasion much pain, according to Dupuytren's statement. The effects of the application will not be completed for seven or eight days; after which the separation of the sloughs, occasioned by the strangulation of the intestinal wall, will allow the instrument to be removed without further trouble, and without the blades being opened. "By the division and loss of substance, the ridge and the double septum, which separate the two ends of the bowel, are destroyed, so as to reëstablish the interrupted communication between them, and restore the natural course of the aliment and fæces."* This treatment appears simple enough and most rational, when considered merely as a mechanical procedure; but in practice we must not be surprised if its adoption were to prove productive of very severe symptoms in many cases, and even fatal in not a few. In the first instance, when closing the blades of the entérotôme, we run the risk of catching between the blades a portion of intestine not implicated in the artificial anus; and if we escape this danger, we have to run great risk of setting up peritonitis, by the action of the instrument on the two surfaces of that membrane enclosed within the blades. Still, on the other hand, it must be remembered that the patient has to submit to a most loathsome condition—great suffering and continual annoyance without any prospect of relief; while in many cases there is also the probability of life being much shortened, from the want of adequate nutrition. The Surgeon, in proposing the operation to a patient, can honestly state that it holds out the prospect of permanent benefit, though its performance is attended with considerable risk; but the patient himself should decide whether to submit to it, after having had placed before him all the reasons for and against its adoption.

The following are the results which Dupuytren arrived at, from his own experience and that of others, in the use of the entérotôme:

Of forty-one operations, twenty-one were performed by Dupuytren, and twenty by other Surgeons. Three cases terminated fatally; one from supposed fæcal effusion; one from peritonitis excited by the operation. Of the remaining thirty-eight, the greater number had no unpleasant symptoms: some had colic, nausea, and vomiting. Fistulæ, more or less extensive, remained in nine; rendering the constant use of a truss necessary. Twenty-nine patients were completely cured, in periods varying from two to six months.

Some doubts have been expressed by M. Jobert† respecting the correctness of Dupuytren's conclusions regarding the safety of this operation; and the former recommends that, in the use of the instrument, the pressure should, in the first instance be gradual, and only increased as the symptoms permit. He has observed all the symptoms of strangulation follow the application of the blades, when applied so firmly as immediately to destroy the life of the part, and states that fatal cases have occurred after such application.

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* Op. cit.

† *Traité des Mal. Chir. du Canal Intest.* t. ii. p. 125.

Surgeons have had but little experience in the application of the entérotôme in this country. Fortunately the cases requiring its use are rare in the present day; but if we are permitted to draw a conclusion respecting the advantages of treatment by the use of the entérotôme, and the effects produced by its application, we would most strongly advocate a gradual, rather than a rapid closure of the blades in any case in which it was considered advisable to employ the instrument.

Foreign Bodies in the Stomach and Intestines.

The introduction, whether accidental or intentional, of foreign bodies into the stomach, is a very common occurrence. The presence of a foreign body in the alimentary canal is generally productive of serious evils; and therefore the management of such a case is well worthy the utmost consideration of the medical practitioner. By the term "foreign body" is intended such a substance as, when introduced into the stomach or bowels, is proof against the rapidly-dissolving action of the gastric fluid; such a substance as retains its original size and general configuration while lodged within, or while passing through, the intestinal tube.

Great varieties of foreign bodies have been found in the stomach and intestines after death; and though it may not be necessary here to enumerate all, it will be found desirable, practically, to distinguish certain varieties from others, and so to classify them; for according to their character, consistence, or shape, they act more or less prejudicially on the parts which surround them.

The following classification will embrace sufficiently the varieties most frequently met with.

1. Round and flat bodies, such as money, fruit-stones, bullets, pebbles, calculi, &c. These substances are generally the least dangerous in their effects.

2. Materials which, by accumulation, form large masses; such as hair, string, the husk of the oat, &c. Such substances generally constitute the largest foreign masses met with in the food-tube.

3. Sharp-pointed or cutting bodies; such as pins, fish- or other

bones, knives, &c. These are generally attended by fatal consequences, if they become lodged in the stomach or intestine.

Foreign bodies may remain in the stomach for a certain period without producing much inconvenience; but generally, when retained, they are attended, sooner or later, by serious if not fatal consequences. The treatment of a case in which a foreign body has become lodged in the alimentary canal, gastric or intestinal, must therefore be ever a subject of extreme anxiety. If the substance be a piece of money or any other small body, it will be passed, often without much discomfort, in the course of a few days, sometimes within forty-eight hours of having been swallowed. But should the substance be a bone, or other irregular-shaped or uneven mass, it may be some weeks before it escapes through the rectum; and its progress through the tube is often attended by pain, and sometimes much distress and suffering.

The early symptoms, indicative of a foreign body in the stomach, will depend very much on the shape and nature of the mass. If it be a pin, or a fish- or sharp meat-bone, or any steel instrument pointed or uneven, the symptoms usually present will be pain referred to the epigastrium—pain sometimes of a very severe character; a sense of weight and discomfort at the stomach; often a desire to vomit, or an actual ejection of the contents of the stomach, and blood, either mixed with the fluid thrown up, or passed in the motions. If the patient is thin and the substance large, it may occasionally be detected through the abdominal wall. When the foreign body is formed by an accumulation of hair or other tissues, introduced into the stomach by degrees from time to time, the symptoms will be chiefly those of severe indigestion, such as a weight and pain in the epigastric region.

The effects of a foreign body passed into the stomach will also differ, according to the shape and consistence of the mass. The substance may be slowly propelled into the intestine, and thence escape externally through the natural outlet; or be retained in the intestine, and there produce fatal mischief. The mass may be retained in the stomach, producing there ulceration and perforation of its coats, and so ultimately fatal peritonitis; or peritonitis may occur as a consequence of partial obstruction, without perforation. The mass rarely remains in the stomach without ultimately producing fatal complications.

The treatment of cases, in which foreign bodies have entered the stomach, must depend greatly on the nature of the substances forming these bodies, as well as upon their shape.

There is nothing more frequently swallowed, and that intentionally, than pieces of money. The swindler in the streets of London, in the habit of passing false coin, when detected in the act, will invariably endeavour to swallow the piece of money intended to have been passed, and will generally succeed in the attempt, even if it be of the size of a half-crown. No evil effects occur in such instances. The treatment usually pursued by the man, in his own person, is peculiar and not irrational. He avoids purgative medicine as worse than useless. On the other hand, he has recourse to a constipating diet, and feeds for some days on hard-boiled eggs and cheese, in excess, beyond his usual diet. His theory is, that the more solid and copious the contents of the bowel, the more sure is the piece of money to be caught in the passing fæculent matter, and thus will be most readily propelled onwards to the external outlet. It is believed, that aperient medicine delays the expulsion of the coin.

It is a very common occurrence, that a pin placed in the mouth accidentally slips down the pharynx. Not unfrequently this happens with children; and the mother, in her anxiety to do something, immediately doses the little patient with castor-oil; and *then* seeks medical advice. In such an accident, it is far better to avoid purgatives; and rather allow the patient to eat plentifully, so that the foreign body may have the best chance of being carried through the intestinal canal, imbedded in and surrounded by fæculent matter. It were better to encourage costiveness than establish relaxation of the bowels.

A sharp-pointed mass retained for a time in the stomach or intestine, may gradually penetrate the walls of the canal, and ultimately escape externally, by perforating the walls of the abdomen. Whenever such a result is indicated by pain, and swelling, and redness of the external parts, the escape of the mass may be hastened by a cautious use of the knife. Previous to the escape of the foreign body, adhesions will have connected the stomach or intestines to some portion of the abdominal wall, and thus the internal wound will be shut out of the peritoneal sac, and the foreign body will be contained in a cavity of its own, between the opening in the bowel and that in the abdominal wall; otherwise, the passage of any substance through the walls of the intestine, into the cavity of the peritonæum, would set up violent if not fatal peritonitis; such as we witness when the bowel is suddenly ruptured.

Needles or pins, when once swallowed, may escape from the intestinal tube, travel through various structures, and subsequently make their exit some distance from the point at which they had passed through the coats of the bowel. It has been affirmed that persons have swallowed whole packets of needles, and that at various times, and in different parts of the body, separate needles have made their appearance. But it is necessary to receive with some caution the evidence of a patient under such a supposed condition. The peculiar impulses of an hysterical mind occasionally induce a female to practise an amount of deception towards the medical attendant, which may induce him, on the first view of the case, to take for granted that which, upon careful investigation, would turn out to be fictitious.

The more globular the mass the greater is the chance of its becoming impacted in the intestinal canal, and producing fatal obstruction of the bowels. Such a mass may pass from the stomach into the duodenum, and make some progress downwards; but as the small intestine becomes less in diameter towards the ileo-cæcal valve, so the obstruction to the passage of the foreign body, as it is propelled onwards, increases at every inch of its progress; and if the size or shape be such as to prevent its passage through the lower portion of the small intestine, all the symptoms of complete obstruction soon occur. This form of foreign body sometimes consists of a calculus, escaped from the gall-bladder, through an ulcerated opening which communicates with the duodenum. Similar results, *i. e.* obstruction, have been known to occur from the retention of calculi formed by the matting together of the husks of the oat, these particles being introduced into the stomach in that well-known national food of the North called "oat-cake." Various specimens of calculi thus formed are to be seen in the Museum of the College of Surgeons.

The stomach has sometimes been found to contain large masses of different substances, which have been swallowed by patients little by little, until the accumulation has become so great as to set up local irritation, disturbance of the digestive functions. and fatal peritonitis. In the 35th volume of the *Med.-Chir. Transactions*, p. 65, the following case is recorded: "Mrs. B., in December 1842, was affected with hæmatemesis, vomiting a washhand-basinful of blood. During the succeeding forty-eight hours she lay in a state of total unconsciousness, the pulse scarcely perceptible. The vomiting did not return, and she slowly recovered." In the autumn of 1845 she complained of frequent sickness, pain in the epigastrium, and in the left groin. "A hard tumour was discovered in the left iliac fossa, which moved freely across the abdomen as she moved from side to side. The size and shape of this tumour were very much like an ordinary placenta, and imparted to the fingers the feeling of being very heavy." Nausea, occasional hæmatemesis, and constipation, were the symptoms most prominent in the progress of this case. In October 1850 the patient died.

"The stomach contained about a pint of semi-fluid matter, and felt very like the crop of a fowl; the duodenum resembled a large sausage stuffed with lead. On cutting into the stomach, it was found partially filled with some gruel-like fluid, and in the lower half an immense number of pins, of a purple-black colour, not corroded, varied in size, all bent or broken, many very pointed. The pyloric half of the stomach presented a remarkably thickened condition of the villous coat, being highly vascular, and raised in rugous elevations like the stomach of an ox. The weight of the pins contained in the stomach was *nine ounces.* An incision made into the duodenum *displayed a mass of pins very tightly packed, of various shapes, similar to those found in the stomach, and wholly obstructing the tube.* These weighed *a pound*, as nearly as could be ascertained."

The author was requested by Dr. Blakely Brown to examine the body of a young woman, æt. 18, who had suffered from pain about a tumour in the epigastric region, and had frequently vomited after meals. She subsequently became sickly; and she appeared childish for her age. After a severe attack of vomiting, and much pain about the tumour, she became collapsed and died.

The cavity of the peritonæum contained several ounces of purulent serum, and the general surface of the intestines afforded evidence of recent peritonitis. On opening the stomach a large mass of hair and string, matted compactly together, was found occupying the greater portion of the cavity, and moulded to the shape of the stomach: a narrowed piece projected into the pyloric end. The hairs were long and black, and were matted together with pieces of string and particles of food. The mass measured when dry six inches in length, three and three quarters in depth, and two and a half across, but was much larger when first removed from the body. Another mass occupied the lower portion of the duodenum and commencement of the jejunum. This portion of the bowel was considerably dilated. This second mass consisted of a smaller quantity of hair than that removed from the stomach, but of a larger proportion of string. The mass was fourteen inches in length, two and a half in depth, and two and a quarter bread in the thickest part. The specimens are contained in the museum of St. George's Hospital.*

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* For case and drawing see *Pathological Transactions*, 1851-52, p. 327.

In the 5th volume of the *Transactions of the Pathological Society* is the record of a case by Dr. Bucknill, in which a man, æt. 22, subject to epilepsy and maniacal excitement, died from the effects of peritonitis. "There was found a perforation of the stomach larger than a shilling, situated at the small curvature of the stomach, with dark-coloured and ragged edges. The peritonæum was in a state of universal inflammation. On opening the stomach, there was found a mass, about four pounds in weight, composed entirely of cocoa-nut fibre, with bits of string, &c. The mucous membrane was healthy, except at the seat of ulceration."

Mr. Poland has recorded in his Prize-Essay the following case: Jas. R., æt. 23, a lunatic, confessed to his attendant to having swallowed the handles of two iron spoons. On examination, apparently in the stomach, there was felt a body of the size of a small egg, and upon deeper pressure the sensation of friction between foreign bodies was elicited. The man subsequently appears to have made some vague statements of having repeatedly swallowed spoon-handles, sand, and pebbles. He made little complaint, but stated that he often suffered from severe pain. He vomited occasionally. One day, about three months after his first confession to the attendant, the patient was seized with sudden severe pain in the abdomen, which continued to increase through the night; and from the effects of this attack he died the following morning.

The cavity of the abdomen was filled with dark greenish fluid and much recent lymph. The stomach was lying in the left hypochondriac region, in rather a vertical position, and was much contracted. About an inch and a half from the pylorus there was a perforation on the anterior surface of the duodenum of the size of a swan-quill. On laying open the stomach and duodenum, "a mass of iron spoon-handles and nails and other articles were seen closely packed together." There were thirty-one entire spoon-handles about five inches long, four half handles, nine nails, half an iron heel of a shoe, one screw, four pebbles, and one button; the weight of the whole mass was 2 lbs. 8 oz. An entire spoon-handle was found in the duodenum, with the flattened extremity towards the pylorus, opposite the perforation.

Of all the remarkable instances on record of a large number of foreign bodies being swallowed intentionally, there is none to equal in interest one recorded by Dr. Marcet in the *Transactions of the Med.-Chir. Society*. In this case, a sailor swallowed at different times a number of clasp-knives, some thirty-seven in all. Some of these he passed whole, per anum, at intervals; subsequently he passed some fragments, and once he vomited a knife-handle. A short time before his death a portion of one was felt fixed across the rectum, but gave so much pain on examination that it could not be extracted. He lived ten years after having swallowed the first knife. On examination after death, one blade was found fixed across the rectum, with one extremity projecting into the muscular parietes of the pelvis. A back spring of a knife had transfixed the descending colon opposite the left kidney, and projected into the peritoneal cavity; the spring was four inches and a half long. In the stomach there were between thirty and forty fragments of knives. For the further particulars of this case we must refer the reader to Dr. Marcet's interesting report.*

Foreign bodies which pass into the intestine are apt to be obstructed in their progress at the ileo-cæcal valve. Such is frequently the case with small bones, fruit-stones, &c., and occasionally the mass will here set up ulceration, and be followed by abscess in the right iliac region. The common result of such an abscess is general peritonitis, and the patient often soon sinks under the attack; but less frequently the abscess opens externally, the foreign body escapes, or is removed, and the patient recovers after a severe and prolonged illness. Fruit-stones are apt to become lodged in the appendix, and are a frequent source of mischief. Such stones are sometimes carelessly swallowed with fruit in large numbers, and are occasionally retained in the intestines for many months without inconvenience; but are as often the cause of much irritation and even troublesome obstruction. Mr. Clement, of Shrewsbury, operated on a patient suffering from obstruction of the bowels, for the relief of which the ascending colon was opened. The patient was so much relieved by the operation, that at the end of six weeks she was able to walk about. About a week subsequent to this period she was seized with colicky pains, and an obstruction occurred at the bottom of the artificial opening, when suddenly a hard mass was shot out from the artificial anus. This substance "was found to consist of five plum-stones firmly agglutinated to each other. These were followed by sixteen other single plum-stones, and afterwards by a very copious fæculent evacuation. On the following day three more stones found an exit, accompanied by two small bones." At different intervals the patient continued to pass plum-stones, the total number collected previous to her death being *one hundred and sixteen.*

Mr. Clement's account of the post-mortem conditions are highly interesting. "The cæcum and the ascending part of the arch of the colon appeared unusual in size, until it was suddenly cut short at the *transverse* part of the arch by the intervention of the most rigid stricture I ever felt. If a piece of whipcord had been firmly tied round this part of the intestine, the occlusion would not have been more complete than was effected by this organic change. The whole remaining portion of the transverse arch of the colon, its descending part, and sigmoid flexure, were collapsed, and formed a thin flaccid tube.

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* *Med.-Chir. Trans.*, vol. xii. p. 52.

"The stricture itself was of cartilaginous hardness, and the closure of the canal so complete, that it would not admit of the passage even of a bristle. The extent of the stricture was not quite an inch, of a white pearly appearance, perfectly smooth, and had no more apparent vascularity than a tendon."* The probability is, that the stricture was the result of effused fibrine, produced by the local irritation, if not ulceration, from the presence of the foreign bodies.

It is still a question open to discussion, and rather to be decided by future experience, how far we may be justified in opening the stomach for the removal of a foreign mass. It must be borne in mind that most of the cases in which a foreign body is retained in the stomach terminate fatally; that life in such cases is limited to a very few years, or perhaps months. The operation of opening the stomach is, on the other hand, a very serious one, perhaps the most serious the Surgeon can undertake; but still the cases, in which we may contemplate the operation, are so hopeless without surgical interference, that the author is rather inclined to recommend the operation, in such cases as might be considered inevitably fatal if left to themselves. The only recorded successful case of gastrotomy was one in which the operation was performed on account of the lodgment of a foreign body in the stomach (v. sup. p. 338).

Foreign bodies which penetrate the abdominal wall may pass into the intestinal canal, or remain lodged in the cavity of the peritonæum. Hennen mentions a case in which a man was struck by a musket-ball, on the evening of the 18th June, at Waterloo. The ball penetrated the abdomen a little below the navel. The principal complaint of the patient, subsequent to the receipt of the wound, was incessant straining to stool; and on the sixth day a bullet, enveloped in mucus, was passed through the rectum. Ten weeks after the receipt of the wound the man passed some bits of cloth by stool. A small fistulous opening continued for a short time in the seat of the original wound, and when this had entirely closed, there was a slight hernial protrusion at the cicatrix.*

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* *Trans. Med.-Chir. Society*, vol. xxxv. p. 209.

Should an elongated body be thrust into the abdomen, it is always desirable to remove it as soon as possible. The difficulties of such a proceeding will, of course, depend as much on the size and shape of the mass as upon its situation; but any difficulties of removal should not weigh with the Surgeon; for if the mass be allowed to remain in the abdominal wall or cavity, more serious results are likely to ensue than if it be at once removed. If allowed to remain in the cavity without an effort being made to remove it, mischief of a serious character is sure to be set up within a short time, and repeated attacks of peritonitis, even if relieved for a period, will destroy the patient sooner or later.

The accidental passage of a cedar pencil into the abdomen, through the urethra of a female, is recorded by Mr. Erichsen in the *Transactions of the Med.-Chir. Society.* In this case the pencil apparently was pushed through "the posterior wall of the vagina, passed upwards behind the bladder, and then traversed the peritoneal cavity. At this time also the intestine was doubtless perforated, and continued transfixed through two of its coils until the time of extraction, a period of nearly eight months." Repeated attacks of peritonitis occurred after the accident. The patient became much debilitated, and subject to constant vomiting. From the examination made previous to an operation, the pencil was felt to be lodged on the outer and right side of the bladder, vagina, and rectum. An incision was made through the abdominal wall over the point where the pencil could be detected, and it was removed without difficulty. The surface of the pencil was stained in places by the intestinal contents. The pencil was five inches long, and was cut at one end to a sharp point, which was still perfect. The patient only survived the operation four days.†

If a foreign body can be distinctly felt in the cavity of the abdomen, having penetrated any portion of the walls, the advantages of early removal will consist in getting rid of an irritating mass, in securing a better prospect of arresting peritonitis, and, should the intestine be wounded, in establishing a more certain escape for its contents through the external wound. If the mass be not removed, the repeated attacks of peritonitis will greatly emaciate and reduce the patient, agglutinate the convolutions of intestines together, and very much complicate matters in any future attempt to relieve the patient by operation.

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* Hennen's *Military Surgery*, p. 408.

† *Med.-Chir. Trans.* vol. xxxix. p. 15.

In conclusion, the author would urge the importance of *early action*, when operative interference is indicated or offers a prospect of prolonging life, in all cases in which intestinal obstruction is the cause of threatened danger. He believes that, in many instances, an operation for the relief of obstruction is fatal in consequence of being performed *too late*—that is to say, after peritonitis has commenced. He believes that the wound of the peritonæum, necessary in many operations for the relief of obstruction, is a minor evil; that it is not the operation or its effects that destroy life; but that when a patient suffering from obstruction dies after operation, he dies from the effects of peritonitis produced by the obstruction, and not from any effects attributable to the use of the knife.

GEORGE POLLOCK.

INJURIES OF THE PELVIS.

THIS essay will comprise a description of the contusions of the soft parts and the fractures and dislocations of the bones forming the pelvis; the injuries of the viscera contained within this cavity or connected with it, and the various methods to be adopted in their treatment.

The relative situation of the pelvis to the rest of the body, the manner in which it is enveloped by muscles, the great strength of the bones themselves, the peculiar nature of their articulations and bonds of union, and the almost circular figure which results from this construction, are circumstances which concur, individually and collectively, to resist the effects of external violence. However, whilst the bones constitute a means of protection for the contents of the cavity, they sometimes become the secondary agents in the infliction of considerable mischief, for fatal injuries are sometimes produced by their fragments perforating the pelvic viscera.

The arrangement of the subject is as follows:

I. Contusions involving the soft parts in contact with the pelvis.

II. Fractures and dislocations of the bones forming the pelvis.

III. Injuries of those organs in relation with the pelvis which are connected with the functions,

A, of Micturition;
B, of Generation, male and female;
C, of Defæcation.

I. *Contusion* of the soft parts covering some portion of the pelvic bones is of frequent occurrence. Thus, a railway labourer often receives a squeeze between the buffers of two railway carriages. The result is more or less bruising of the soft tissues, and the laceration of smaller or larger blood-vessels, which, in some instances, gives rise to a large extravasation of blood. I have seen nearly the whole of the integuments detached from the external surface of the glutei muscles and fascia, without any sign of a scratch on the skin. Blood had been effused into this pouch, and a large swelling was the result. Around the swelling ecchymosis appeared a few days after the infliction of the injury. With repose and the local application of stimulating lotions, the blood became absorbed. Large swellings, the result of the effusion of blood, occasionally arise after kicks from a man or beast, the soft parts being well placed, between the iron boot-toe or shoe and the dorsum of the ilium, to receive the full influence of such force. In these injuries, the blood is extravasated beneath the gluteal fascia, and forms a circumscribed swelling, throughout which the fluctuation of its fluid contents is distinctly perceptible. Ecchymosis does not appear around the swelling, even after the lapse of several days from the receipt of the injury. Under these circumstances the collection of blood might be mistaken for an abscess, if the history of the case were not carefully ascertained. The nature of the swelling may be diagnosticated, however, by learning that it appeared soon after the receipt of a blow; that no pain, before the kick was received, preceded its formation; and that its development had not been attended with any constitutional disturbance.

Contusions of an apparently trifling nature at first sight may yet be attended with appalling results. Thus, a delicate, strumous, badly-nourished boy shall receive a blow on the pelvic region, as a kick, whilst at play, the primary effects being merely a local tenderness or stiffness. But in a few days intense constitutional disturbance may arise, and death ensue from disease of the membranes of the spinal cord.

II. Dislocations and Fractures of the Bones forming the Pelvis.

Injuries of the pelvic bones and joints are usually severe. They are attended with more or less risk to life, which does not ensue solely from the damage done to the bones themselves, but arises from the contents of the region being involved in the mischief.

It would be idle to write a systematic description of the dislocations and fractures of each pelvic bone separately, since fracture and dislocation occur so frequently in combination, and as the effect of the same amount of violence inflicted on the patient. Indeed, as the pelvic bones are united together by interarticular fibro-cartilage, as well as ligaments, a solution of continuity between their articulating surfaces differs widely from the displacement of the articular extremities of the long bones which compose diarthrodial joints. Hence it happens that very great violence is required to sever the union between the pelvic bones, and the same degree of force may produce a solution of continuity of the osseous texture in preference. Even in those cases in which the greatest amount of dislocation is effected, as, for example, of the os innominatum from the sacrum, the borders or edges of the articular surfaces of either one bone or the other, or even of both bones, are frequently broken off. This fact, incontestably demonstrated by preparations in every anatomical museum, renders it extremely difficult to decide during life whether the case be one of fracture simply, or a combination of the two injuries. The only movable articulation, to be noticed in this essay, in which articular cartilage and a synovial capsule exist, is that between the sacrum and coccyx; and to a description of the dislocation of the latter bone a few lines will be devoted.

The massive strength of the pelvic bones, and the capability of resisting violence enjoyed by the tissues which unite them together, combine to neutralise the effects of the application of ordinary force, which in bones constituted with less strength would give rise to a solution of continuity in the osseous texture. The effect of a moderate degree of direct violence, is to break off the more salient parts of the bones. Thus, a man receives a kick upon the ilium from another person, or from a horse, by which a fragment is broken off from its crest. The anterior superior spinous process of the ilium is not unfrequently separated from the crest of the bone in this manner.

The greatest amount of injury, however, is inflicted by heavy, crushing weights passing over the pelvis, or by falls from great heights on to very hard substances. By such violence the bones may not only be broken and disjointed, but the important organs within the region may also be injured by fragments of bone perforating their tissues.

The diagnosis of simple fractures of the pelvic bones is usually unattended with difficulty. Unless there be much contusion, or a large extravasation of blood over the injured bone, the crepitus, arising from the movable fragment rubbing against the fixed bone, is easily felt.

The treatment consists in enjoining absolute rest, and the application of a bandage in such a manner as to prevent the movement of the piece of bone which has been broken off.

The os innominatum may be broken into fragments by the head of the femur being violently driven against the acetabulum. A few cases of this injury are recorded. One is related by Sir Astley

Cooper, in the first part of his *Surgical Essays*, page 51, and Plate II., fig. 6. A preparation in the museum of the Royal College of Surgeons beautifully illustrates the nature of this injury, and the reparation which may take place. The details of the case are recorded by Mr. Earle, in the 19th volume of the *Medico-Chirurgical Transactions.* It appears from the preparation, that the lines of fracture diverging from the acetabulum have followed the track of the union of the three separate portions of which the fœtal bone was composed.

Injuries of this kind may be mistaken for dislocations of the head of the femur, or fracture of its neck. They are usually accompanied with more or less deformity about the hip, and pain on any movement of the hip-joint. The sensation of crepitus, when the lower extremity is moved, seems to be diagnostic, however, of the nature of the injury.

Portions of the brim or border of the acetabulum are occasionally chipped off. In this injury the deformity which results simulates that of dislocation of the head of the femur; for, partial displacement of the head of that bone sometimes accompanies the injury. The departure from the normal outline of the region, with the existence of the crepitus of fracture, will assist to establish the diagnosis.

In a paper by Mr. Benjamin Travers, which was read before the Medico-Chirurgical Society in 1854, he has given an account of two cases which he assumes to be illustrative of the fact of a fissure or crack passing through the acetabulum, without displacement, or any other primary sign of the nature of the injury which can be relied upon. The very acute pain produced *by pressure upon the projecting spine of the os pubis*, and the inability of the patient to maintain the erect posture immediately after the infliction of a blow or fall which produces the mischief, he considers diagnostic of the injury. There is little or no swelling, and the limb may be cautiously handled, and gently rotated, without producing much complaint on the part of the patient, being recumbent, which posture he is forced to observe for many weeks. At first the limbs are of equal length; but when the patient recovers, the injured limb is found to be permanently shortened. Mr. Travers believes that there is reason to suppose, that in these accidents certain changes occur, secondarily, in the head of the femur, that it undergoes a change in shape, the articular cartilage is absorbed, and eburnation ensues. The subject certainly requires further investigation; and this short allusion to it is introduced in the hope that it may lead to more extended inquiries.*

The coccyx can be broken, or dislocated from its articulation with the sacrum, by the application of direct force. The injury may be produced by a kick or a fall on to any projecting hard body. It is stated that this bone is sometimes broken in the effort of parturition.

Great pain at the end of the sacrum and in the immediate region of the injured part, increased by the act of walking, or in the performance of defæcation, induces the injured person to seek relief. If the bone be broken, the sensation of crepitus would be sufficient to indicate the injury. If, upon passing the finger into the rectum, and when feeling the anterior surface of the lower extremity of the sacrum, an unusual projection be felt, with mobility of the coccyx and no crepitus, it would indicate that, probably, the coccyx was dislocated either forwards or backwards. The one variety could be distinguished from the other by ascertaining which of the two bones formed the prominence on the anterior aspect of the sacrum. If the projection is formed by the base of the coccyx, this bone would be dislocated forwards. But, if the end of the sacrum produces the prominence, the coccyx must have been displaced backwards.

In the treatment of fracture, absolute rest is required. The reduction of the dislocation may be effected by pressure. With the index-finger introduced into the rectum, whilst the patient is under the influence of chloroform, the bone may possibly be brought into its normal relations with the sacrum; after which perfect rest must be enjoined.

III. (A.) INJURIES OF THE ORGANS OF MICTURITION.

A. *Injuries of the urinary bladder.* A solution of continuity of the tissues of the bladder may be caused

1. By direct violence,
    - *a.* *Without* fracture of the pelvis; produced by the passage of a wheel over the hypogastric region, by kicks, falls, and perhaps by violent contraction of the abdominal muscles.

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* See also *Further Observations in Surgery*, by B. Travers, 8vo, London, 1860.

    - *b.* *With* fracture of the pelvic bones, the fragments of which have not injured the bladder; produced by the same causes as before stated.
- 2. By foreign bodies penetrating its walls,
    - *a.* Through the abdominal parietes; produced by projectiles from fire-arms, bayonet or sword thrusts, and other cutting instruments, as a trocar in paracentesis abdominis, or in paracentesis of the viscus itself for relief of retention of urine.
    - *b.* From the rectum; produced by bougies, stakes of wood or iron, a trocar, &c.
    - *c.* Introduced along the urethra; produced by knives, sounds, catheters, or lithotrites.
    - *d.* From the vagina, during instrumental parturition.
    - *e.* By fragments of broken pelvic bones.
- 3. By accumulation of urinary secretion,
    - *a.* In the fœtus; in consequence of imperforate urethra.
    - *b.* In the adult; in consequence of an impediment to the passage of the urine along the urethra.

1. *Ruptured or burst urinary bladder.* The tissues composing the urinary bladder may be torn or lacerated by external violence, without the abdominal walls showing any signs of the mischief. This injury may be inflicted when they are in a perfectly healthy condition; but the details of the cases prove that it only occurs when the bladder is distended with urine. Under ordinary circumstances, the anterior walls of the pelvis and the strong recti muscles protect this viscus from the effects of direct violence; but, when it is distended with secretion, and the tension of the abdominal muscles is relaxed under the influence of inebriation, that part of the bladder which is in relation with the urachus, the anterior abdominal walls, and the peritoneal membrane, becomes unusually exposed and liable to be torn.

Morbid anatomy teaches that the rent may pursue a vertical, transverse, or oblique course. In the majority of instances, the aperture has been found to extend from the attachment of the urachus through the posterior wall of the organ, involving not only the proper tissues of the viscus, but its peritoneal covering as well. Under these circumstances, this great serous sac is wounded, and the urine escapes from the bladder into the cavity of the peritonæum. In some rare examples, the anterior wall of the bladder only has been torn, and the urine then becomes extravasated into the connective tissue of the pelvis.

The records of fifty examples of this injury show that, with the exception of three, all the cases terminated fatally. Of the three cases which recovered from the injury, in one only the symptoms were those of extravasation of urine into the peritonæum;[*] in another the extravasation was into the pelvic connective tissue, and this was complicated with fracture of the pelvis;[†] and the third was of the same nature, but without that complication.[‡]

In the majority of cases, the injury was produced by direct violence, such as a kick above the pubes, the passage of a cart-wheel over the hypogastric region, or the fall of an antagonist on to the same part. The injured person has generally been drunk, the bladder distended, and the signs of the injury in nearly all cases immediately manifested. In rare instances, patients have passed a few hours after the accident in comparative freedom from urgent symptoms, but they were men who were drunk at the time, and probably too anæsthetically intoxicated to be conscious of their condition. In a very few cases, the bladder has been torn without any evidence of direct local violence. These patients are said to have fallen upon their backs from a height or down stairs.

The immediate and prominent symptoms of this injury are, intense pain in the abdomen, rapidly followed by collapse, and urgent desire to pass urine, with repeated but ineffectual attempts to void it. The patient sometimes dies at this stage. But if reaction takes place, all the well-known symptoms of peritonitis rapidly supervene, and a fatal result is sure to ensue, if this disease be not arrested. The variety of peritonitis may not be of the most sthenic kind; that is, after death plastic effusions may not be found uniting the abdominal viscera together, or forming large masses of lymph. But that kind of peritonitis is developed which is commonly associated with the most fatal results. An abundant sero-purulent effusion exists, of an unorganisable character, which bathes the abdominal viscera, and appears in a few cases to have been drawn off by the catheter when introduced by the urethra and through the wound of the bladder. After the first urgent symptoms have passed off, the case becomes one of local peritonitis, and the usual train of phenomena characterising that malady appear in succession; the only indications of the injury, in addition to those of peritonitis, being the immediate effects referable to the viscus injured. Thus, the sufferer continues to evince a constant desire to micturate, and a few drops may occasionally pass from the urethra, as the result of his efforts. Most commonly, however, not a drop is voided. Urgent tenesmus is another most distressing symptom, and by the repeated, straining, but ineffectual, attempts to defæcate, a little urine may be expelled. From this continued desire to empty the bladder, and failure in voiding urine, the Surgeon is induced to pass a catheter. As no impediment to the introduction of the instrument exists, and as perhaps but an ounce or two of urine flows through the tube, the catheter is pushed further into the pelvis, and, without doubt, as some of the recorded cases demonstrate, through the laceration in the posterior wall of the bladder into the peritoneal cavity. The result has been to draw off a very large quantity of fluid, in one instance, "between five and six pints;" a quantity of urine which it is difficult to believe a ruptured bladder could contain. Yet the fluid is stated to have appeared clear and normal. In some cases, the fluid drawn off by the catheter has had a little blood mixed with it, just enough to give it a slight tinge of red.

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[*] Mr. Chaldecott's patient; *Prov. Med. and Sur. Journal*, 1846, p. 333.

[†] Porter's patient. The case related by F. Rhynd, *Path. and Prac. Observations on Strictures*, &c., 8vo, 1849, p. 48.

[‡] Mr. Syme's patient; Contributions to the *Path. and Prac. of Surgery*, 8vo, 1848, p. 332.

This injury must be treated like peritonitis; with the exception of adopting suitable treatment to prevent dilatation of the bladder by an accumulation of urine, and the necessity for the patient voiding it, and to guard against the possibility of repeated escape of the secretion through the laceration into the peritonæum, and of acute inflammation of the peritonæum, engendered by the escape of an irritating fluid into this large serous cavity. The case can only be regarded in this light from the first moment of the accident. For that the extravasation of urine into the peritonæum must excite inflammation of the serous membrane, can never be for a moment doubted. Post-mortem examination of the cases sufficiently attests the fact. The primary effects in the immediate neighbourhood of the injured viscus are seen in the firm union of the serous surfaces, and in effusions of plastic lymph which completely shut off the pelvic region from the larger portion of the great peritoneal sac. All treatment must be subservient to that which is capable of arresting or controlling peritonitis. None can, therefore, so much conduce to the salvation of life, as that which effectually limits the primary influence of the irritating fluid to the pelvic region. The plan of treatment commonly adopted in cases of acute peritonitis must therefore be rigidly carried out in this injury. Upon opium, and its effects upon the constitution, our chief reliance must be placed.

The patient should be brought under the influence of opium as quickly as possible. A full dose of tinctura opii or liquor opii sedativus, in a little camphor-julep, must be administered, and repeated at short intervals, if the abdominal pain continues. As soon as the pain subsides, the quantity of opium may be diminished, but if the pain increases, more opium is required. Food of every kind should be withheld for twenty-four or even forty-eight hours after the infliction of the injury, and then only just sufficient to sustain life allowed. A safe guide to the supply of food is indicated by the wants of the sufferer, and unless the desire for nourishment is expressed, it is better to withhold it until the necessity is pointed out by nature. Small pieces of ice placed in the mouth, to allay the distressing thirst, may be permitted to the patient *ad libitum.* The external surface of the body must be kept as warm as possible, and every measure adopted to promote cutaneous perspiration. The abstraction of blood, by means of leeches applied over the region of the injury, may in some cases be desirable, but usually the attendant prostration scarcely admits of their employment. Cutaneous local counter-irritation is beneficial, and warmth and moisture applied over the abdomen favour the functions of the skin.

The conservation of the urinary bladder in a state of complete contraction and repose, is one most essential step towards the healing of the wound in its walls. The Surgeon should remember that the secretion of urine would be lessened, and the quantity, perhaps, become very small indeed, as generally occurs in collapse and peritonitis. Very little necessity, therefore, exists for the repeated introduction of instruments, in order to empty the bladder, during the first twenty-four, or even forty-eight hours, after the injury. A perusal of the recorded cases of this injury will not fail to impress the reader with the apparent want of caution displayed in the introduction of catheters beyond the neck of the bladder, also of the danger which must accrue when a metallic catheter is pushed far into the cavity of he organ, because so small a quantity of urine passes through it when it is really in the bladder and only there. Will an anatomist believe that a ruptured bladder can contain "between five and six pints" of urine, or a physiologist that this quantity would be secreted in about forty hours, whilst the patient was suffering from peritonitis, the result of extravasation of urine into the peritoneal cavity? The inference, with the majority of readers, would be, that he catheter had passed through the rent in the viscus, and removed the serous effusion together with the extravasated urine from he peritonæum. The chief point, therefore, with the Surgeon must be to maintain the contracted state of the bladder, because in this condition the edges of the rent remain in close approximation. And for another reason too. In a hollow viscus, constructed as the urinary bladder is, the mucous membrane holds a somewhat variable position to the other tissues of which the organ is composed. The loose attachments of this membrane admit of a variation in its relations to that tissue with which it is in immediate connexion, during the opposite conditions of extreme distension and contraction. So that when all the coats are torn through, in a line perfectly corresponding at the moment of extreme repletion, the non-contractile mucous coat may overlie the aperture in the other tunics, when the viscus is empty, and thus form a plug or valve to assist in preventing the further escape of urine through the laceration. And furthermore, the rent would assume very different proportions or dimensions in a dilated and contracted state of the organ.

In order, therefore, to guard the patient against any injury which may arise from the catheter being pushed through the lacerated opening in the bladder, a large flexible instrument should be used, which has an opening at the extreme point, and not at the sides near the end, as the catheter in ordinary use has. The flow of half an ounce of urine, or even less, through such an instrument is sufficient to satisfy the operator that the bladder contains no more. The Surgeon must satisfy himself upon physiological principles regarding the quantity of urine drawn off, and not calculate upon a very abundant secretion. Should the catheter be secured in the urethra? If its point could be fixed just within the orifice of the bladder, the urine as secreted would drop from the open end, and all danger of its entering the peritoneal cavity would be thus avoided. But if there be any risk of introducing it too far, or of leaving it even in the rent, it is clear that the repeated introduction of the instrument is preferable. A reply to this query must then, I think, be submitted to the judgment of the Surgeon. The patient must not, on any account, be allowed to make a voluntary effort to micturate; and the use of the catheter should be persisted in for *not less* than fourteen days after the receipt of the injury.

b. The urinary bladder has been ruptured by the same local cause as produced a fracture of the pelvis. This result has happened *without* the fragments of the bones inflicting the injury to the viscus. An instance of this injury is related by Mr. Partridge, in the *Pathological Transactions*, volume v. page 194. Injuries of this kind are usually so severe in their consequences that the prognosis is most unfavourable. The treatment of the case will not differ from that before described.

2. Foreign bodies may inflict injuries on the urinary bladder, after penetration of the abdominal walls; from the neighbouring canals; or from the excretory canal, the urethra; and lastly, fragments of the pelvic bones may lacerate or penetrate its walls.

Penetrating wounds of the abdominal walls produced by projectiles from fire-arms, bayonet- and sword-thrusts, nails, spikes, the horns of animals, or surgical instruments, may extend into the urinary bladder. Bullets have lodged in this viscus, and remained in its cavity sufficiently long to become covered with deposits from the urine. Some interesting cases are related by Mr. Guthrie,[*] to which, and to the essays on GUN-SHOT WOUNDS and on INJURIES OF THE ABDOMEN, we must refer the reader.

Iron or wooden stakes which have entered at or near the anus, after penetrating the walls of the rectum, may perforate the urinary bladder. Injuries of this kind are on record. A very singular case is recorded by Mr. Prescott Hewett, in which the rectum and urinary bladder were transfixed by the patient falling upon the broken leg of a chair. Death resulted in this case from peritonitis, arising from extravasation of urine into the peritoneal cavity.[†] But a case has been described to me by my friend Mr. Buée, of Slough, in which recovery took place. A man 46 years old, whilst at play with a companion, was pushed off a cart-load of fagots, and fell on to a pointed stake which had been driven into the earth. This passed through the anus, transfixed the walls of the rectum, and tore the posterior region of the bladder immediately behind the prostate gland. The index-finger was passed into the bladder through the wound. The man complained of intense pain. He was bled, and a full dose of opium administered. Mustard cataplasms and fomentations were applied over the abdomen. He was kept in bed, and in two months after the injury the urine was voided by the urethra.

Sounds, catheters, and lithotrite instruments, if employed without due care, may be thrust through the walls of the bladder. Perforations may be made in the bladder with catheters, under the impression that the patient is suffering from retention of urine, whilst effusion into the abdomen is the real cause of the malady. M. Velpeau states, that he has known this accident to occur at one of the large hospitals in Paris. The patient was sounded, and no urine came away; they pushed with greater force, and a very large quantity of serous fluid escaped. This was a case of ascites, and the instrument had penetrated the peritonæum. M. Velpeau adds, "I was sent for three times in 1832 to urgent cases, and I then saw how very easy it would have been to have made the mistake. One of the patients had not passed any urine for four days, and had his hypogastrium very much distended. I found the bladder empty. He died the same day, in consequence of an intestinal rupture, from external violence, which caused the effusion."*

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[*] *Commentaries on the Surgery of the War*, 5th edit. 1853, pp. 572 et seq.; also *Med.-Chir. Trans.* vol. xxxiii. pp. 197, 198.

[†] *Trans. of the Path. Soc. of London*, vol. i. p. 152.

In the use of instruments during parturition, direct injury may be inflicted on the bladder; or secondary mischief may arise by violent contusion of the part, causing extensive sloughing. And if care be not observed to ascertain whether the bladder is distended, the passage of the child's head in labour may cause it to burst.

Cases are on record, and have occurred in my own experience, in which fragments of the pelvic bones, the result of fracture, have penetrated this viscus, causing a fatal issue from extravasation of urine.

3. The urinary bladder is sometimes ruptured by an accumulation of secretion. Cases of this kind are, however, very rare. The injury occurs in fœtal life and in the adult.

Mr. Wilkinson King has published the report of the case of a fœtus in which the bladder was burst by accumulated urinary secretion. It happened in consequence of the urethra being congenitally impervious.† Also, cases bearing on this subject are related by Dr. Robert Lee.‡ In the museum of the Royal College of Surgeons, there is a preparation (No. 1967) of "the bladder of a woman which burst near the entrance of the ureter, in consequence of neglected retention of urine." See Diseases of the Urinary Organs.

Foreign bodies in the bladder. The following remarks apply to foreign bodies introduced into the bladder along the urethra.

Portions of catheters and bougies, metallic or flexible; pieces of straw, of tobacco-pipe, pen-holders, hair-pins, a piece of French chalk, of slate-pencil, a bodkin-case;—these are all articles which have been removed from the bladder or urethra.

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* Velpeau, *Traité complet d'Anat. chir. gén. et topograph. du Corps Humain.*

† *Guy's Hospital Reports*, vol. ii. 1837, p. 508.

‡ *Med.-Chir. Trans.* vol. xix. pp. 238 et seq.

If the foreign body remains long in the bladder, it generally becomes coated with deposits from the urine. In 1829 a sailor was in Guy's Hospital, under the care of Mr. B. B. Cooper. Three months before, a portion of a bougie which he was using broke off, and remained in the bladder. After many ineffectual attempts to remove it with the forceps had been made, Mr. Cooper performed the usual lateral operation of lithotomy. The piece of bougie, coated with phosphates, was removed. The man, however, subsequently sank from disease of the kidneys. The case is related in *Guy's Hospital Reports*, 1844, p. 176, and the piece of bougie is in the hospital museum.

Catheters made of gutta-percha become by age and use rather brittle. A man was admitted into Guy's Hospital under my care, who, after having used an instrument of this material for some time, broke off a piece of the end as he was removing it from the bladder. He soon felt inconvenience from it; and on examination it was easily felt with a sound, as well as some concretion which had been deposited on it. I introduced a lithotrite, and succeeded in breaking the tube in pieces. The fragments were voided with the urine by the ordinary act of micturition, and the patient was entirely relieved of his difficulty.

An elderly man, who had been in the habit of introducing a silver catheter and retaining it for some time, when in bed, fell asleep, and rolling over, broke the instrument. About half was withdrawn, leaving the remainder partly in the bladder and partly in the urethra. I introduced a long pair of forceps by the urethra, and fixing the catheter by pressure in the perinæum, was able to grasp the tube and extract it. Fortunately the broken end of the metal was rather rough and slightly bent at the site of fracture, which afforded a good hold for the forceps.

Mr. H. Norris sent to Sir Astley Cooper a number of calculi formed upon a piece of straw. The patient from whom they were removed had been in the habit of introducing a tube of this material to empty his bladder.*

In the museum of Guy's Hospital there is the section of a large calculus, the nucleus of which consists of a portion of tobacco-pipe.

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* A relation of the case, and a drawing of the stones, is given in the *Guy's Hospital Reports*, 1840, p. 241.

Sir Astley Cooper used to relate a case in which the nucleus was a silver tooth-pick.*

A man entered Guy's Hospital, under my care, who had passed the wooden handle of a magnum-bonum steel-pen into his urethra and bladder, with the view to stir up some sediment which he believed to be therein. Many attempts were made with differently-shaped forceps to extract it. None of them held it sufficiently firmly to allow it to be pulled from under the pubic arch. Its end was distinctly felt through the walls of the urethra in front of the scrotum. It was necessary to open this canal at that point, and then it was easily removed.

Incised wounds of the urethra and corpus spongiosum urethræ heal very quickly, and experience has shown that the removal of bodies impacted in the urethra is accomplished with less injury to the canal by external incision than by subjecting the patient to the risk of lacerating the tissues by the use of forceps, and the pressure exerted by the foreign body to be removed.

The direction of all incisions should be parallel with the long axis of the urethra; the opening in the integuments should be larger than in the corpus spongiosum, and that in the last structure longer than in the sub-mucous tissues and mucous membrane. The edges of the wound are on no account to be brought together with sutures, but it should be allowed to heal by granulation. There is no necessity for the introduction of a catheter.

An application was made to the late Mr. Avery to remove a two-pronged wire hair-pin, such as ladies employ to arrange their hair, from a man's urethra. The patient had introduced it with the bent end foremost, and when he let go of the pointed ends they sprang sideways, and became impacted in the walls of the urethra at some distance from its orifice. Mr. Avery introduced a metallic tube into the urethra, pressed the points of the pin together, and conducted them into the tube, where they became fixed; both the tube and pin were then easily withdrawn.

But the strangest thing to introduce into this canal was a piece of French chalk, scraped to a convenient size and shape. To the middle of this one end of a piece of string was tied, and to the other end of the string the half of a common shoe-horn. The man actually came into Guy's Hospital with this dangling from his penis. Mr. Thomas Callaway removed it.

Women occasionally introduce foreign bodies into the bladder.

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* *Guy's Hospital Reports*, 1837, p. 273.

The comparative shortness of the urethra enables the Surgeon to remove them with greater facility than in the male sex. The operation may be accomplished after dilatation of the canal, when attempts made before have failed.* Mr. Steel removed from the bladder of a girl a bone bodkin-case, with a piece of thread tied around its middle.†

Foreign bodies occasionally pass from the urethra, the entrance of which into the canal is not always explicable. An interesting case of this kind, in which the substance seemed to be a fish-bone, was voided by a patient who was under the observation of Mr. B. Cooper. It is recorded in *Guy's Hospital Reports*, 1841, p. 189.

Mr. Alfred Roberts, of Sydney, sent to Guy's Hospital museum a piece of slate-pencil which had been removed from the bladder, and which, as that gentleman states, is proved to have entered the bladder from a neighbouring viscus.

The presence of a foreign body in the bladder having been detected, it must be removed. In the female this may be accomplished by dilating the meatus, and making use of forceps especially adapted to seize and retain the body. It may perhaps be broken with a lithotrite. In the male the length of the urethra precludes the hope of extracting a foreign body from the bladder by means of forceps introduced along that canal; but it may be crushed with a lithotrite, and the fragments afterwards expelled. If this cannot be done, an incision may be made in the centre of the perinæum, the urethra opened, and the extraneous body removed by dilating the prostatic portion of the canal, or the usual operation of opening the bladder, as in the lateral operation for lithotomy, can be performed.

Injuries of the urethra. 1. *Simple incised wounds of the urethra* readily heal when longitudinal. Such wounds are dangerous in proportion to their depth, as regards their direction, and the tissues which may be implicated in the injury. A man, 52 years old, was admitted into Guy's Hospital, under my care, in 1855, who had fallen upon a chisel a few days before admission. This instrument had inflicted a wound at the back part of the scrotum, and cut into the urethra. When admitted, the tissues of the scrotum, penis, perinæum, and hypogastric region of the abdomen, were infiltrated with urine, and the integuments gangrenous in several points. Free incisions were made into the connective tissue of the regions involved in the disease; but, in spite of the liberal administration of stimuli and opium, he became delirious, and died within a fortnight after the receipt of the injury. The rule in all like cases is to prevent the infiltration of the tissues with urine; and therefore there can be no objection to enlarge the external wound, if there be the slightest reason to fear that this secretion may become extravasated. The man whose case is related above died from the effects of extravasation of urine, namely, gangrene; and had he sooner applied for relief, it is quite possible he might have lived.

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* See *Med.-Chir. Transactions*, vols. viii. and xii.; two papers by Sir Astley Cooper.

† *Guy's Hospital Reports*, 1853, p. 316.

Contused and lacerated wounds of the urethra. Injuries incidental to the female urethra are rare. It is so short and so well protected by the surrounding parts, that contusions which would cause laceration of this canal in the male, generally produce their influence on the vagina or a part of the vulva. It is liable to injury in the treatment of difficult parturition, the effects of which are shown in the existence of fistulous communications between this canal and the vagina. The treatment of such cases is described in another part of this work,—Diseases of the Female Organs of Generation.

But the urethra of the male is often lacerated; at any age, especially in boyhood or youth. The injury is produced by violently striking the perinæum in falling astride a firm resisting body, such as the top rail of an iron or wooden fence, the back of a chair, the sharp edge or corner of a box, or of any hard body, in fact, which just fits the "crutch" or perineal region. The urethra is unfortunately so placed as to receive the full violence of such a blow. For, between the pubic arch above and the resisting body below, it is violently driven against the former, and becomes torn transversely. It may even be completely severed. In this case the continuity of the mucous membrane is destroyed, and if the surrounding parts be much detached from their fascial connexions, the two torn extremities of the urethra lie widely apart from one another. The portion of the canal most frequently torn in this manner is that which is placed in relation to the deep perineal fascia, and the rent may be anterior or posterior to this structure. The greatest risk to life attends the last variety; for if extravasation of urine takes place into the connective tissue of the pelvis, the danger of intrapelvic suppuration and peritonitis is imminent.

The simplest form of injury to the urethra very often happens to boys, who in climbing over railings fall astride the topmost bar. A little blood flows from the urethra, as the immediate result of the injury; and, after the lapse of a few hours, the scrotum becomes ecchymosed and swollen. The urine voided by the efforts of the patient soon after the receipt of the injury is often bloodless, or but slightly tinged with blood. Its contact with the abraded surface gives pain, and, in consequence, the child is averse to repeat the effort. In course of time, however, he is impelled by an urgent desire to empty the bladder. The attempts being fruitless, a Surgeon is called, and his assistance is required to relieve the bladder of its contents. The retention of urine is caused partly by the effusion of blood into the cells of the corpus spongiosum urethræ and surrounding tissues, and partly by inflammatory effusion in the immediate neighbourhood of the wounded mucous membrane. Great caution, care, and gentleness are required in the introduction of an instrument, which should be, at first, a flexible catheter without the stilette. If this fail, the stilette may be inserted; and if the obstacle be still impassable, a metallic catheter must be employed. The introduction of the instrument is sometimes facilitated by gently pressing the point against the superior wall of the urethra. The catheter should not be secured in the bladder, but warm fomentations or evaporating lotions may be applied to the contused regions. If there be active hæmorrhage, the local application of ice is indicated.

The following case is a good illustration of the symptoms, the treatment, and its happy results, in a contused wound of the urethra. A man thirty-eight years old fell astride the back of a chair, and very soon afterwards passed blood from the urethra. Five hours after the receipt of the injury he was admitted into Guy's Hospital. The bladder was distended, blood flowed from the urethra, and he was suffering much from local pain. I introduced a *large* flexible catheter, through which the urine flowed freely without blood. This was secured to the penis, and allowed to remain in the bladder the three succeeding days. The catheter was then withdrawn, as the urine could not pass through it; but I was unable to introduce another. The instruments seemed to run behind the prostate gland. As the man could not void urine, I incised the perinæum along the line of the raphé. This region contained much extravasated blood, and the urine flowed freely from the wound. Every thing proceeded satisfactorily until the sixth day after the operation, when profuse hæmorrhage occurred. It was arrested by applying cold and pressure. At the end of a month after the injury the perineal wound was entirely closed, and all the urine voided by the urethra. When he left the hospital there was no contraction of the urethra, for I could pass a large metallic sound without causing any pain.

The most extensive injury to the urethra and surrounding parts may exist without there being any indications in the perineal region for some time after the accident. A young man was brought into the hospital who had fallen astride one of the large hooks which connect railway carriages. A few hours after the accident the perinæum showed no signs of injury, and a little blood only passed per urethram. He desired to micturate; made an attempt to empty the bladder, but failed to pass a drop of urine. I introduced a flexible catheter without difficulty, and drew off an ordinary amount of urine tinged with blood. I withdrew the catheter, surmising that no impediment would subsequently arise to prevent the introduction of an instrument. However, greatly to my disappointment, the next time micturition was desired, the patient was unable to pass a drop of urine, and a catheter could not be introduced into the bladder. During the interval which had now elapsed since the introduction of the catheter, the integuments of the perinæum and scrotum had become ecchymosed, swollen, and painful on pressure. An incision was made through the integuments along the whole extent of the raphé, and the severity of the injury was at once detected by gentle examination with the finger. The tissues, covered by the integuments, were extensively torn, the prostate gland could be felt; but as a very large quantity of extravasated blood filled the perinæum, the wound of the urethra was not discoverable. Soon after the perinæum had been incised the urine escaped at the wound, suppuration was established, and cicatrisation proceeded favourably. The man was able to pass water from the urethra in a very good stream. After a time, however, the cicatrix of the urethra contracted, and a phosphatic calculus formed in the bladder. This was extracted by the lateral operation; the wound healed favourably, and the man passed water in a very good stream when I last saw him. In this case, it is not probable that the urethra was completely divided transversely.

The following case is one of complete transverse division of the urethra in the perinæum. A boy, fourteen years old, was brought into Guy's Hospital in January 1856. The penis, scrotum, perinæum, and hypogastric region were black with effused blood. Retention of urine had existed many hours, and the distended bladder could be felt, as high as the umbilicus. This injury had been produced by a fall astride a rail. There was not even a scratch on the integuments any where. Of course, an attempt was made to pass a catheter, but it could not be introduced into the bladder. I therefore made an incision along the line of the raphé, and the urine soon began to trickle away; but I was unable to discover the distal end of the urethra. The patient, from being in a state of collapse, recovered in a few hours. The urine was passed through the perineal wound for some weeks, and, by degrees, through the whole length of the urethra, with but a few drops from a fistulous opening in the perinæum. After attempting various measures to close this, without success, I divided the perinæum and urethra upon a grooved staff, and introduced a flexible catheter, in the hope that the urethra might be established by healing over it. In this I was disappointed; and the boy left the hospital with the urethra contracted, and the urine passing out of the perineal fistula. He next entered another metropolitan hospital, where the Surgeon, by the performance of an operation similar to that above described, succeeded in closing the fistula, reëstablishing the urethra and keeping it pervious, so long as instruments were daily employed to prevent contraction. The boy left the hospital, neglected to pass the bougie, and the urethra contracted. He then suffered from retention of urine; a No. 1 catheter was passed, and by increasing the size of the instrument the urethra was dilated. Urinary abscesses subsequently formed in the perinæum, fistulæ were established, and to cure these the perinæum was divided as before. This wound never entirely closed; he was again admitted into Guy's Hospital, suffering with stricture and perineal fistulæ, and left it only slightly relieved. Such is the result of a case of complete transverse division of the urethra, and this one is an example of that class of injuries.

The danger to life resulting from extravasation of urine into the pelvic connective tissue, as a consequence of rupture of the urethra and laceration of the surrounding textures, is illustrated by the ensuing case. It also demonstrates the ill effects arising from delay in cutting open the perinæum, as well as from plugging the part with sponge to arrest hæmorrhage.

A healthy man, 38 years old, fell astride a chest, and struck his perinæum against one of its corners with great violence. He came soon after to the hospital, and my dresser passed a flexible catheter without any difficulty, and fastened it to the penis. The next day the scrotum, perinæum, and penis were infiltrated with blood, and quite black. The urine was passed freely through the catheter. The following day the catheter became filled with coagula, and blood passed along the urethra by its sides. It was removed forty-eight hours after the infliction of the injury, and as the urine did not flow away, I incised the perinæum along the raphé. The coagulum was large, and the hæmorrhage profuse. The urethra was severely torn, and the finger could be passed deeply as far as the prostate gland and by its sides. A catheter could not be introduced into the bladder. The hæmorrhage was arrested by the local application of cold, and a piece of sponge placed in the wound. The next day evidences of local peritonitis appeared, pain in the hypogastric region, shivering, small wiry pulse, and at last hiccough. Opium was freely administered; but the constitutional disturbance increased, the wound became gangrenous, and the man expired upon the eighth day after the receipt of the injury. The decomposition of the body was far advanced when the post-mortem examination was made, and no well-marked indications of peritonitis or of pelvic suppuration were discernible. Death was, however, certainly due to the severe constitutional excitement caused by the injury and its consequences; and if sufficient local evidence of the fact was wanting, its absence must be attributed to the condition of the body at the time the necropsy was made. Doubtless the man died from constitutional disturbance, caused by the extravasation of urine into the pelvic subperitoneal connective tissue; and as regards the treatment of the case, the question is, whether it would not have been better to have incised the perinæum sooner after the injury. In cases of this nature it is impossible to judge of the extent of the mischief in all of them, and as in this instance the catheter was in the bladder, and the urine flowed freely through it for thirty-six hours, I did not consider the operation of incising the perinæum demanded, immediately after admission. In all probability the extravasation of urine was extending, in consequence of the fluid escaping by the sides of the catheter; and as the coagulum was quite superficial, just beneath the integuments, the urine infiltrated the deeper-seated tissues, and passed behind the deep perineal fascia, which was lacerated. I should not again make use of a sponge and plug to restrain the bleeding, unless a catheter could be retained in the bladder; for I think it partly assisted in preventing the escape of the urine with the freedom so desirable in these cases. Local pressure with the finger is the best means to arrest hæmorrhage from this region.

The local treatment in all cases of injury to the urethra, in which there is reason to fear that extravasation of urine may take place, is now clearly established. It consists in making an incision along the raphé of the perinæum, to allow the fluid to escape with the utmost facility. Delay in the performance of this operation causes imminent risk to the life of the patient, and probably an aggravation of the local mischief.

The constitutional treatment consists in supporting the powers of the patient, and in administering opium if there be much local tenderness, especially in the hypogastric region. Should symptoms of peritonitis arise, the treatment suitable to arrest that malady must be adopted.

Injuries of the urethra, inflicted from its mucous surface, frequently result from the passage of foreign bodies along this canal. In this category must be classed the lacerations of the urethra and its surrounding textures, by the forced introduction of sounds and catheters, in an effort made to reach the urinary bladder. The necessity for this operation arises in consequence of a contraction in some part of the calibre of the excretory tube. When, therefore, the urethra is wounded in front of the stricture by catheterism, the direction of the wound is from its orifice on the glans penis towards the urinary bladder. An opening more or less valvular is made, and extravasation of urine does not commonly take place. The course of the wound, "or false passage" as it is termed, varies much in length and in its relations to the surrounding parts. If the floor of the urethra be perforated a little behind the bulb of the corpus spongiosum urethræ, the wound may run behind the prostate gland, and then penetrate the neck of the bladder. If the point escapes through the roof of the urethra, it may run behind the pubes and enter the anterior wall of the bladder. If it escapes from the urethra in front of the stricture, it may pass by it on one side or the other, and entering the canal again posterior to the constriction, a twofold perforation of its walls will be established. In these cases extravasation of urine will be almost certain to ensue. Many of the cases of retention of urine admitted into the hospitals require the operation of puncture of the bladder from the rectum, in consequence of the existence of false passages resulting from unskilful attempts made to pass an instrument through the contracted urethra. Even fatal hæmorrhage may ensue from a wound of the urethra thus made.

A Surgeon is often called upon to treat these injuries. They are brought under observation at two stages: the first, soon after the false passage has been made, when the patient is suffering from retention of urine, and the bladder in a state of extreme distension filling up the pelvis. What is to be done? Opium in full doses has been administered; the patient has been placed in a warm bath, perhaps chloroform has been inhaled; two or three, or even more, Surgeons have failed in their efforts to introduce a catheter; not a drop of urine has escaped from the urethra, but only some blood. Upon inquiry, we find the patient has been the subject of stricture for many years, and that for some weeks the urine has only dribbled away, and at times but a few drops could be voided. To delay the relief of the distended bladder is now no longer admissible, and the cries and entreaties of the patient to be relieved compel immediate proceedings. One more attempt is made to introduce a catheter into the bladder, and although different sizes are selected, and the utmost dexterity may be employed, still the point of the instrument will run into the false passage, and, with the index-finger in the rectum, it may be felt near the prostate gland. By depressing the shaft of the catheter, and with a little force, at the same time directing the instrument with the index-finger in the rectum, it may be made to enter the bladder. The urine flows freely, and the sufferer is at once relieved. But is the relief permanent? The bladder is empty truly, but a false passage is established, by which the urine subsequently escapes into the connective tissue between the organs of the pelvis; and the case becomes one of extravasation of urine. The condition of the patient is not, therefore, improved by this operation.

Another operation by which the distended bladder may be emptied, is that of making an incision in the centre of the perinæum, and opening the urethra from that region behind the stricture. This has been successfully performed in several cases.

Two other operations are practicable. 1st, to introduce a trocar and canula from above the pubes into the bladder; 2dly, with the same instruments to puncture the bladder from the rectum. I have no hesitation in strongly recommending the last operation; and this recommendation is founded upon the observation of a very large number of most successful cases. By this procedure, extravasation of urine will be prevented. The details of the operation would be out of place here.

The second stage is that of extravasation of urine. The escape of this fluid does not always depend upon the catheter being pushed into the bladder, but may arise in consequence of the urethra bursting posterior to the constriction. This last condition generally depends upon a morbid state of the canal in that region, set up by the continued pressure of the retained fluid, by which the tissues are inflamed, and at last ulcerate or slough.

The treatment of cases of extravasation of urine need not be fully detailed here, especially as we have already dwelt upon this point when describing lacerations of the urethra causing the same lamentable consequences.

A curious injury of the mucous membrane and submucous connective tissue of the urethra occasionally takes place during the occurrence of a chordee. The patient feels something snap about two or three inches within the canal, a few drops of blood escape, and considerable tenderness or soreness is experienced during the act of micturition for a few days afterwards. The mucous membrane has been torn. The result is cicatrisation; and as the cicatrix contracts, a hard wiry ring remains, which occasionally establishes a stricture. This may subsequently require treatment by dilatation or incision.

When the urethra is lacerated in the prostatic portion of its course, the blood which flows from the wound passes backwards into the bladder, coagulates, and distends the organ. Great suffering results; constant desire exists to empty the viscus, and ineffectual attempts are made. The distended bladder may be easily felt in the pubic region, and although a catheter is passed, the size of the distension of the bladder is not diminished. Perhaps a few drops of blood and urine flow through the instrument, and that is all. Under these circumstances the viscus may be emptied by fixing a syringe to the end of a metallic catheter, which should be first introduced into the bladder. It is always advisable to make use of a larger instrument than that with which the injury was inflicted. To make the junction of the catheter with the syringe impermeable to air, some warmed white- or bees-wax should be pressed around them at that point. Elevation of the piston slowly and steadily will then remove all the coagulated blood from the bladder.

FOREIGN BODIES IN THE URETHRA.

The reader is referred, on this head, to the section on STONE.

(B.) INJURIES OF THE ORGANS OF GENERATION.

Injuries of the penis. Contusions and wounds of this organ are uncommon. In contusions, the effused blood extends freely in the loose subcutaneous connective tissue, and produces an unusually dark purple hue in the part. If blood be effused into the cells of the cavernous bodies, it produces a remarkable induration at the seat of injury.

Incised and lacerated wounds of the integuments only differ from those of other parts in consequence of the loose attachment of those textures to the fibrous covering of the corpora cavernosa. When the wounds are large, their edges become widely separated; so much so in some cases as to lead to the belief that part of the integument is entirely removed.

There is scarcely any region of the body in which the edges of wounds require to be so carefully adjusted as in this. Sutures are indispensable to their treatment. Whether the wound be incised or lacerated, the edges must be maintained in contact with either metallic wire or silk sutures, and dry or wet lint should be gently rolled round the part to support it.

As the result of a contusion of the glans penis, I have seen that part of the organ become gangrenous. A man, 79 years old, said that he struck the glans penis in a fall. It became sore, inflamed, and subsequently gangrene attacked it. It sloughed off, the wound soon healed, and he passed water as well as ever.

Incised wounds of the prepuce require ligatures. This fold of integument is sometimes injured in coition, and the result is more or less inflammation, giving rise to paraphimosis. The frænum præputii may be torn by the same act. Hæmorrhage to a considerable extent occurs, but it is easily controlled by cold or pressure.

An injury, by no means very rare, is inflicted by children who tie thread or string around the root of the penis. Becoming frightened, and unable to remove the ligature, they delay to speak of it, and the result is, at first congestion, afterwards inflammation, and at last ulceration at the site of the ligature. The removal of the offending cause suffices to place the parts in a condition to heal quickly, with the application of water-dressing.

Injuries of the prostate gland. The prostate gland is so deeply seated in the pelvis, that it is not liable to injury except by penetrating wounds. Incised wounds of the prostate usually heal very quickly. Such are those made in the operation of lithotomy. The most common injury to which this gland is liable arises from laceration either of one of its lateral lobes, or of its posterior and central part, by the forcible perforation of its tissues with sounds and catheters. This injury can scarcely be regarded as of rare occurrence, judging, at least, from the number of specimens accumulated in the museums of London. The growth connected with this gland, and denominated the "third lobe," is frequently so situated at the orifice of the urethra as to offer an impediment, not only to the flow of the urine, but to the introduction of an instrument from the urethra.

This contingency should be always remembered when any obstruction is met with at the moment the catheter reaches the orifice of the bladder. The perforation of this lobe is readily effected with a metallic instrument; it may, with care, be avoided, by the employment of a flexible catheter and stilette, in most cases. When the end of the instrument impinges on the obstruction, it should be withdrawn from the urethra about half an inch; then, by fixing the catheter with one hand, drawing the stilette out of it for about an inch with the other, and depressing both hands, or gently pressing the catheter onwards by itself, it glides over the third lobe and enters the bladder.

The indications of perforated prostate may not be immediate. But, after the lapse of an hour or two, the patient experiences an urgent desire to empty the bladder. He repeatedly attempts to do so, but in vain. Perhaps a few drops of blood escape from the urethra. Becoming alarmed, he sends for a Surgeon, who finds the pubic region occupied by a hard mass, which is very painful when pressed. The Surgeon again introduces a catheter, but no urine escapes. By dint of pressure above the pubes a few drops of urine mixed with blood are expressed, then a long coagulum, again a little more blood and urine, and next a coagulum, and so on until the mass in the pelvis is somewhat reduced in size. But still there it remains, and, as an accompaniment, the urgent desire of the patient to empty his bladder. Together with these local circumstances, the constitutional disturbance hourly increases; mental excitability for a few hours is associated, at a later period, with great restlessness. Nausea, and intolerance of solid food, with a clammy white tongue, changes after a time to vomiting, continued retching, and the attendant distress. The clamminess of the mouth passes into a state of parched dryness, and the thirst is most distressing. The tongue becomes dry, brown, crisp and rough on its surface. The pulse, at first full, rapid, and incompressible, by degrees becomes small and wiry, maintaining its rapidity, although, perhaps, not regularly. Respiration is at first accelerated, and lastly hurried. The skin is covered with perspiration, which in the later stages becomes cold, and the face assumes a congested, livid aspect, not unlike that seen in cases of peritonitis.

The first thought which suggests itself to the patient as well as the Surgeon, will be to relieve the distended bladder. How is this to be effected? The introduction of the catheter gives no relief, and even the passage of the instrument through the injured prostate might tend to reopen the wound. However this may be, I consider the best plan is to introduce a large metallic or flexible catheter;

and then, by applying at its end a syringe, as before described, the blood may be abstracted. The bladder may be irrigated with tepid water, and the operation repeated if necessary. Cold water injected into the rectum may arrest any further bleeding.

The powers of the patient must be well supported, and sedatives or opiates administered to obtain repose.

I have never met with any injury of the vesiculæ seminales.

Injuries of the scrotum and testicles. The scrotum is often contused, and the effect of the laceration of small vessels ramifying in its textures is shown by effusion of blood taking place in the loose connective tissue of the organ. This causes it to swell and become of a black hue. The treatment of a case of this nature demands perfect rest, with care and arrangement to prevent the part remaining pendent whilst the patient is in bed. A small pillow or sandbag should be placed between the thighs. The most suitable application is a slightly stimulating and evaporating lotion which may be composed of liq. ammon. acetatis, spirit. tenuior, and distilled water, in suitable proportions. Lint wetted with this fluid should be placed over the injured part.

Incised and lacerated wounds of the scrotum are produced by falling upon sharp substances, or astride of rails, hooks, &c. The wound is sometimes sufficiently large to permit the escape of one or even both testicles without their undergoing any injury. This extrusion of the testes partly depends upon the contraction of the fibres of the dartos, which corrugates the scrotum, and causes it to shrink to such a degree, that it might appear as if a considerable portion of the structure had been carried away as the result of the injury. Such not being the case, means must be employed to relax the contractile fibres of the dartos. Warmth and moisture will accomplish this. The region should be enveloped in lint wetted with hot water; and when the integuments of the scrotum are sufficiently relaxed, the edges of the wound should be drawn together over the testicles by means of sutures. Either the interrupted or uninterrupted suture may be employed, and the material of the suture be silk or metal, according to the inclination of the Surgeon. Adhesive plaster is detrimental. Dry lint should be laid over the part, if the case be one of an incised wound; moist lint, if the scrotum has been contused as well as torn and lacerated. Cold lotions are then to be applied in order to maintain the contractility of the dartos; for if the integuments are allowed to become relaxed and pendulous, suppuration takes place, and the pus collects in the most depending part. Repose and posture are points of too great importance to be neglected in the treatment of these injuries.

Injuries of the testis, epididymis, and vas deferens. The testicles may be seriously injured by pressure and contusion. The former injury frequently occurs in frays and broils by the forcible grasp of the hand of an antagonist; the latter, by suddenly coming in contact with some resisting body, as when astride a rail or saddle on a horse's back, or by a blow from a swiftly moving body, as a cricket-ball. The constitutional effects of these injuries are in some cases immediate. Prostration, syncope, nausea rapidly followed by vomiting, and intense pain ensue, and some hours elapse before the suffering subsides. The pain is not confined to the organ injured, but extends in the track of the spermatic cord to the inguinal, abdominal, and lumbar regions, in which last it sometimes becomes most severe.

Absolute repose, the local abstraction of blood, the application of warmth and moisture, the support of the injured organ upon a pillow, are the local means to be adopted to prevent inflammation arising. This effect of the injury, however, frequently follows, and in the adoption of suitable constitutional and local remedies to arrest its progress, the usual precautions in regard to the diathesis and powers of the patient must be employed.

Wounds of the testicle are uncommon. A punctured wound may be inflicted by the careless use of a trocar in the performance of paracentesis scroti for hydrocele. The effect produced is more or less tenderness and swelling of the organ, and occasionally the extravasation of blood into the tunica vaginalis. If an operator has reason to conclude that the testis has been thus punctured, it would be well to enjoin rest and apply cold lotions. By neglecting all precautions he might become involved in difficulty.

Incised wounds of this organ are very rare. They cannot easily occur without the serous cavity of the tunica vaginalis being opened, and the Surgeon should remember this in the adjustment of the edges of the wound. All serous surfaces being so active in pouring out adhesive lymph, the surfaces of the tunica vaginalis testis and reflexa would soon unite together when brought in contact; and thus the wound of the integuments would be all that remained to cicatrise.

Complete section of the spermatic cord with a sharp instrument should be treated with the hope that union of the divided structures may occur. The divided artery would require a ligature, but the ends of the vas deferens might be adjusted by a suture placed through the surrounding connective tissue in such a manner as to keep them in close contact.

Rupture of the vas deferens. Injuries of the excretory duct of the testis, or vas deferens, are not noticed by surgical authors. Mr. Hilton has favoured me with the history of three cases, in which he believes this duct was torn completely across.

Case 1. A gentleman, between nineteen and twenty years old, was skating, and, in attempting to cut a particular figure, in which act he swung himself round with great effort, he suddenly slipped, so that his right leg was violently abducted. At the same moment he felt something give way in his right groin, accompanied with great pain. The right testis had not been the seat of direct injury, yet it began to swell almost immediately, and in a few hours blood passed from the urethra. Perfectly clear urine flowed away through a catheter, introduced into the bladder, without any blood. This was an indication that the blood had entered the urethra, and that it did not come from the bladder or kidneys. The blood seemed to be arterial, but it was in small quantity. There was continued tenderness and pain near the right inguinal ring, and swelling of the right testis. Leeches were applied over the lower part of the abdomen, and he was confined to bed two or three days, suffering much local pain, resembling peritonitis, with considerable pyrexia. The bleeding from the urethra did not continue after the second day. The testis remained swollen for several weeks, and then began to waste, until at last it was reduced to about one-third its normal size. At this time, now six years since the accident occurred, the patient reports that the testis is of the ordinary size of the organ in a boy of twelve years old. In its present condition it causes no inconvenience.

Case 2. A man, about 28 years old, was wheeling quickly a barrow with two handles in the dark, when he was suddenly arrested in his course by the barrow meeting with an obstruction. The weight recoiled upon him and shook him very much at the lower part of the abdomen. He stated that he felt something "give way" in his right groin. Arterial blood flowed from the urethra almost immediately after; and when seen an hour after the injury, he was then bleeding. Mr. Hilton passed a catheter, and drew off perfectly clear and bloodless urine. This case was attended with nearly the same local symptoms as the last, although not quite so severe or so prolonged. It was treated in the same way, except that a few leeches were applied to the testis, and with advantage. A fortnight after the injury, the right testis was much enlarged, and slightly painful on pressure. The opportunity for further observation has not occurred.

Case 3. A gentleman, about 60 years old, was running up-stairs in pursuit of one of his children. Hoping more certainly to overtake the child, he made a violent effort to catch hold of her foot, as she was turning the corner of the stairs. This he failed to do, and fell with his knees upon the step, but did not strike the groin. He felt a sudden pain and something "give way" in the right groin, close to the internal abdominal ring, and presently blood trickled from the urethra. Mr. Hilton saw the patient about two hours after the injury had been inflicted. He introduced a catheter into the bladder, and the urine passed through it perfectly clear and bloodless. The patient was confined to bed for nearly fourteen days, with swollen testis and pain deeply seated behind the internal abdominal ring. Leeches were applied to the lower part of the abdomen and testicle. During four or five days a small and diminishing quantity of blood passed from the orifice of the urethra. The right testis subsequently diminished very considerably; and when an examination was made, several months after the injury, it was not more than half the size of the left.

In the details of the above cases there seem to be very good reasons to concur in the opinion, that the injury sustained by these men was the laceration of the vas deferens. Mr. Hilton considers that this duct is divided within the abdomen, between the internal abdominal ring and the point where it crosses the ureter, and that the blood flows from the artery which accompanies it. The blood from this vessel traverses the tube, and so enters the prostatic portion of the urethra, anterior to the bladder, thus leaving the urine free from blood.

He adduces, in corroboration of the views above expressed, the details of a case dissected by him, in which he accidentally found one testis excessively atrophied, and the vas deferens of the same gland ruptured and closed at both ends. The ends were at least two inches apart. The lowermost was lying near the crossing of its course with the ureter; the upper end was adherent to the surrounding connective tissue, near the internal ring. The vesicula seminalis on the same side was smaller than that on the opposite.

The indications of this injury are a sudden and violent pain in the groin, arising as the result of severe exertions, or of a blow;

the flow of bright red blood from the urethra, although the urine which the bladder contains is free from blood; gradually increasing pain, which extends over the lower part of the abdomen, accompanied with more or less pyrexia. The bleeding ceases; the pain subsides; but the testis on the affected side becomes at first swollen and tender, and finally diminishes, until, after the lapse of a few weeks, it becomes atrophied.

Absolute rest in bed; the local application of leeches, warmth and moisture; and such constitutional remedies as serve to control and remove pyrexia, subserve the purposes of treatment, both general and local.

Cases of this injury are doubtless rare, and these have been here introduced to attract the notice of the profession.

*Injuries of the uterus.** The following arrangement will be adopted in describing the injuries of the uterus.

In the unimpregnated state:
- 1. Wounds. 2. Contusions.

In the impregnated condition:
- 1. Wounds. 2. Contusion, without and with rupture.

Rupture during parturition:
- 1. Idiopathic. 2. Traumatic.

Wounds of the unimpregnated uterus are very rare. Except in combination with violent and extensive injuries to the pelvis, there are, indeed, no cases on record. As Duparcque observes, "the fibrous, and as it were cartilaginous resistance of the womb whilst empty; the small size of the organ; its mobility, and its situation within a bony cavity, efficiently protect it from all violence capable of affecting the integrity of its walls."

The same remarks apply to contusions of the empty organ as to wounds.

In wounds in the impregnated state, the danger depends more on the hæmorrhage which may be produced, the inflammation excited, and its consequences, and the premature expulsion of the ovum which may follow, than on the fact that the uterus is wounded. Punctured wounds, or small rents by sharp instruments, may cause the dribbling away of the amnial fluid quite as much as large injuries, thereby rendering abortion a certain result.

Many cases of goring by cattle are on record; and from the wounds so produced, the whole or part of the fœtus has escaped into the peritoneal cavity, or completely through the abdominal walls.

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* In this section I have availed myself of the knowledge of Dr. Braxton Hicks, the talented accoucheur-physician at Guy's Hospital.

Planchon relates a case of a pregnant uterus being punctured by a nail projecting from a cart. Blood mixed with the liquor amnii escaped from the wound. Death occurred in sixty hours.

Bandelocq mentions a case where the uterus was torn open by an ox, and recovery ensued.*

There is a case of recovery from puncture by a pitchfork reported in the *American Journal of Medicine*, April 1847.

The pregnant uterus has been tapped with a trocar for ascites, from which mistake no ill effects followed.

The wife of a Sepoy was riding an ox, which stumbled. She fell on its horns, one of which entered her abdomen and uterus. Through the wound the hand of the fœtus protruded. The fœtus was extracted *per vias naturales.* The intestines protruded, but were replaced, and the woman perfectly recovered.†

The uterus has also been wounded in criminal attempts to procure abortion, the instrument used passing through its walls, producing occasionally fatal hæmorrhage. A case occurred in the practice of an eminent accoucheur-physician, who examined the uterus after death, which took place from inflammation. The pointed instrument had entered the os uteri rightly, but, instead of following the axial curve, it was pushed towards the sacrum through the posterior wall of the cervix into the recto-vaginal pouch of the peritonæum.

The treatment of wounds of the pregnant uterus depends much on the condition of the parts. If the fœtus have *not* escaped, a wound of this organ must be treated on the usual antiphlogistic principles; loss of blood by venesection or leeches, fomentations, mercurials, and full doses of opium to check pain and uterine action. If the fœtus *have* escaped, and there is yet a probability of bringing it through the natural passages, the effort must be made with the greatest care; should, however, the greater part present at the wound, then our best plan will be to draw the remainder gently through, removing the placenta, as in the cæsarean section, and finishing the proceeding, and adopting the same after-treatment, as in such cases. If only a small portion, as a limb, of the fœtus project through the wound, it will be advisable to replace it, as early and with as much gentleness as possible; taking care, the moment labour sets in, to be ready to dilate the os uteri, and extract the child, as soon as the hand can be introduced, by drawing down the feet, in order that it may not again be driven through the uterine walls by their contractions.

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* See *Hull's Defence of Cæsarean section.*

† *London Medical Gazette,* Oct. 1846.

Contusions of the pregnant uterus, without rupture. During the early months of pregnancy, blows and injuries may produce inflammation of this organ; the symptoms of which will be severe pain in the hypogastric region, extending to the vulva, perinæum, and thighs, combined with inflammatory fever. The treatment will consist in depletion, calomel and opium, and the local application of leeches and hot fomentations. Abortion is generally the result; but abscess or chronic inflammation of the womb may be the sequel. Duparcque relates a case in which an abscess formed in front of the uterus from a blow on it in the sixth month of pregnancy. It was only discovered, after delivery, by its projection across the mouth of the uterus. It was cured by puncture with a straight bistoury.

From the changes produced in the walls of the uterus by this inflammatory action, it has been observed that injuries to that organ undoubtedly predispose to rupture in subsequent pregnancies and labours.

During the latter months of pregnancy, or at the full term, contusions give rise to inflammation of the uterus and to peritonitis. They are attended with more severe suffering if the consequent contractions be more powerful, and the child larger; and labour is almost certain to follow, impeded by the swollen uterus, and the as yet rigid os.

As to the treatment; "Under these circumstances," says Dr. Rigby, "we must trust almost entirely to the lancet to aid the speedy dilatation of the os uteri; for, until the circulation has received an effectual check by fainting, the dilatation of the parts cannot proceed, nor can any attempt be made to give artificial assistance. The abdomen should be well covered with a hot linseed-meal poultice, hot decoction of poppies thrown up the vagina, the bowels opened by a simple enema, and then a warm opiate injection to allay irritation." We would also recommend the inhalation of chloroform, but not carried to its fullest effect; and from what we have witnessed of its beneficial effects in obstetric operations, we may look for the greatest benefit: first, by its power of checking temporarily uterine contraction; secondly, from its relaxing powers to open the os; and lastly, from its anæsthetic action.

Contusions, with rupture. This is the most serious consequence attendant on contusions to the pregnant womb. The ovum is expelled into the abdominal cavity, or more rarely through the natural passages. Besides contusions, over-exercise, leaning against hard substances, violent vomiting, and stooping have been known to cause the catastrophe.

In the early months of pregnancy the symptoms are ambiguous. They may be said generally to resemble that of rupture of any abdominal viscus. The most marked are collapse, intense pain, internal hæmorrhage, or an escape of blood from the vagina. In the latter stages of pregnancy, the symptoms point more clearly to ruptured uterus, and the child may be felt among the intestines. When death does not immediately ensue, and the case is left to nature, either fatal peritonitis is set up, with all its attendant symptoms, or the fœtus becomes surrounded with a cyst, the result of plastic effusion, and is thereby shut off from the viscera. The ovum may remain tolerably quiescent in this cyst, but sooner or later it causes irritation, and endeavours to reach the surface, either by the vagina, rectum, or through the abdominal walls.

The treatment being the same as that required when the accident occurs during labour, the reader is referred to that division (pp. 508-9).

Rupture of the uterus during parturition. This is one of the most appalling accidents that can complicate parturition. It may be considered under two conditions: firstly, idiopathic; secondly, traumatic. The first arises from an abnormal condition of the uterine walls, its tissue being altered by former disease, or by former wounds. It may also result from prolonged efforts to expel the child where an obstruction exists in the natural passage. Sometimes the walls give way before more than a few pains have arisen, while some patients have been four days in labour before rupture took place. The average duration of labour before rupture is about twenty-one hours.

Version, and the unskilled or careless use of obstetric instruments, not unfrequently produce the second variety of this accident. Although rash and inconsiderate attempts cannot be too strongly condemned, it is important to know that rupture has occurred even to the most skilful practitioners. From the reports of some cases it would appear that violent movements of the fœtus have given rise to this accident, though it is highly probable that the escape of the child through its walls produced the violent movements of the uterus, and thus cause has been confounded with effect. If, however, the movements were the true cause, we can hardly believe that the uterine walls were in a healthy condition at the time.

Ruptures of the uterus generally may be divided into three classes. In the first the rent is confined to the vaginal cervix, and perhaps a portion of the vagina. These cases are usually without danger; they soon heal up, and probably they are much more frequent than is commonly acknowledged. Occasionally, as in a case mentioned in the *Guy's Hospital Reports*, 1859, the hæmorrhage resulting has proved fatal. In the second class rupture is unattended with the escape of the fœtus through the rent; and in the third the fœtus escapes into the peritonæum.

The symptoms of ruptured uterus are variable, dependent on the extent of the rent, the amount of hæmorrhage attending it, and whether the fœtus has passed through its walls. The most common symptoms are a sudden sensation of tearing, or of something having given way in the abdomen, followed by fainting, and all the symptoms of collapse, cessation of the pains, frequently recession of the presenting part, frequently hæmorrhage from the vagina. These symptoms are those which more especially indicate the third class of the accident, and usually denote the escape of the fœtus into the abdominal cavity, where it can be generally felt. However, this is not always the case, for collapse may continue to a fatal end, even where the fœtus remains in utero; for bleeding into the peritonæum may cause nearly the same symptoms. Again, the uterus may be severely ruptured, and though the pains may be abated in force, they are still adequate to delivery. This termination is rare. But many cases have occurred in which it was impossible to fix the time of the rupture, therefore it is not unlikely that some cases recover without the suspicion of their existence.

The treatment recommended in this formidable accident varies very much. From the researches of Dr. Trask, to whose valuable paper we must refer the reader,* it appears that in those cases where the fœtus had escaped into the peritoneal cavity,

Gastrotomy after this accident lost	24	per cent.
Turning, perforation, &c. . . .	68	„
Abandoned to nature	78	„

In a case of such difficulty, it is well to know what line of treatment affords the greatest chance of recovery; and from the above we may safely conclude that gastrotomy affords the best, which is therefore strongly urged by Dr. Trask. However, in any given case, much depends on collateral circumstances. If the child have only in part escaped into the peritoneal cavity, then it is proper to introduce the hand, seize the feet, and deliver as in version; if the head, however, be impacted in the pelvis, it is right to apply the forceps, and if that be impossible or useless, to perforate it. If the child have escaped wholly into the cavity, and only a few hours have elapsed, the hand should be passed through the rent, if it can be done with ease, the legs grasped, brought back through the rent, and delivered by the natural channels. But should much time have elapsed, or the rent be firmly contracted, so as to require some force to pass the hand through it, it will then be advisable to perform gastrotomy without delay. Again, should the escaped fœtus have, at the time of our arrival, already set up irritation, we must then wait until the plastic products of inflammation have formed a cyst around it, whereby most commonly it remains for a time comparatively quiescent. It will be a matter to determine, after waiting two or three weeks, whether we should make an opening through the abdominal walls, or delay still longer until there is a marked tendency to point forwards. In any case, should we find from the touch that the fœtus is lying just beneath the walls, there can be no hesitation in cutting down at the end of three weeks from the accident; for it must be remembered that the fœtus may take the direction of the bladder or intestines, and form openings into them, causing protracted and immense suffering. Sometimes, however, the fœtus remains in the cyst dormant for many years, but these are the exceptions.

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* *Cases of Ruptured Uterus, with Remarks*, by Dr. Trask; *American Journal of Med. Science*, January and April 1848, and July 1856.

The intestines may escape by the rent, after delivery per vaginam, and therefore in every case examination should be made if possible, in order to reduce them when necessary; as death has taken place in some cases from strangulation of the bowel.

The laceration may take place in any direction. The relative frequency of its position is as follows:—Rupture of body and fundus, 63; ditto of cervix, involving more or less of body of uterus and vagina, 64.

Injuries to the vagina. Unconnected with parturition, these are not very common. But few are recorded. They are inflicted by falling, or sitting upon pointed instruments, which may penetrate even to the abdomen. A case is mentioned in which a triangular hay-knife entered the vagina, lacerating the perinæum, and passed into the abdomen, whilst the long handle remained projecting from the vagina. The handle was cut short, and the remaining portion was extracted, after great difficulty, at the end of nine hours. Local and general bleeding was employed, and recovery took place in seven days.*

Two cases have been related to me in which patients have died from the hæmorrhage resulting from a wound inflicted on the vagina. It is a subject for regret that in neither case was the nature of the wound in the artery discovered after death, by careful dissection.

My informant was hastily summoned to a lady, whom he found lying on the floor in a pool of blood, at the point of death; in fact, she scarcely breathed after his arrival. The husband had left her in perfect health, a very short time before, to accompany a friend a little distance from the house. On his return, he found his wife on the floor, and faint. A Surgeon had seen the patient, and discovering a flow of blood from the vagina, placed a compress and plug of lint therein, and gave stimulants. The hæmorrhage, however, continued, and death took place about an hour after the infliction of the injury. A post-mortem examination of the wound *only* was made. On separating the labia, a lacerated wound, which extended upwards and forwards, was seen, and the internal pudic artery was found to have been divided. The accident was occasioned by the lady going into a dark bedroom to micturate, and sitting down upon a water-ewer, the handle of which was broken off, leaving a portion sharp, jagged, and projecting about an inch, which produced the injury.

Mr. Durham, demonstrator of anatomy at Guy's Hospital, related to me the following case: A woman was knocked down by a man, and immediately a large pool of blood appeared on the floor. She died in a short time. The blood flowed from the vagina, in the walls of which there was a wound extending towards the internal pudic artery. At first it was thought that the woman had been stabbed with a knife, but on careful examination it was discovered that she had fallen on a spittoon. The weight of her body broke this utensil, and a sharp-pointed fragment of it probably inflicted the injury.

Injuries connected with parturition. Rupture of the cervix uteri frequently extends into the vagina, assisting the escape of the fœtus into the peritoneal cavity, or allowing the intestines to protrude.

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* *Lancet*, 1833-34, vol. ii. p. 112, from *Revue Médicale*.

The symptoms in such cases resemble those of ruptured uterus, and must be treated accordingly.

The unskilful use of obstetric instruments, or the extraction of the broken-up fœtal cranium, have often caused severe injuries to the vagina; sometimes the former have passed through the walls, at the junction of the cervix, tearing the uterus from the vagina.

In attempts to procure abortion, the vagina has been injured, and occlusion or constriction of the passage being the result, has been detected at the subsequent labour.

The vagina has also been torn, together with the hymen, in the attempts at coitus for the first time.* In two cases described to the writer, in recently married women, the bleeding was very alarming to both parties, consequent upon the tearing up of a considerable portion of the mucous membrane. Similar effects are also produced in rape. The legal points of these cases may be seen in works on Medical Jurisprudence.

The passage of the child's head in primiparæ will occasionally push before it the internal membrane of the perinæum, so as to cause it to tear, leaving a raw surface internally, which is difficult and slow to heal. In two instances this caused contraction and severe pain afterwards. In one case coitus was impossible for nine months at least after labour. The irritation of the lochiæ probably retards the healing process.

All these wounds require but little surgical interference beyond the injection of warm fomentations, great cleanliness at first, and, if they be slow to heal, some stimulating injection, as blackwash, zinc and alum lotion, a lotion of nitrate of silver, or the application of the solid nitrate.

All injuries of the vagina are exceedingly prone to be followed by contracting cicatrices, which in part or even wholly occlude the passage, rendering coitus more or less difficult, painful, and even impossible. They add very seriously to the dangers of labour, ending even in rupture of the uterus.† Peritonitis is apt to follow injuries of the vagina, especially if they be near the uterus. Any symptoms, therefore, of this disease must be carefully watched.

The protracted detention and pressure of the child's head within the vagina is sometimes followed by a slough, which may extend anteriorily into the bladder, causing vesico-vaginal fistula; or posteriorly into the rectum, causing recto-vaginal fistula. By the former the urine passes in part or wholly into the vagina; and by the latter the fæces, rendering the condition of the sufferer very pitiable. The treatment of the results of this injury is described in the essay on Diseases of the Female Generative Organs.

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* A specimen of this injury, which proved fatal, is preserved in the collection of obstetric preparations presented by Mr. Stone to the museum of St. George's Hospital.

† Trask on *Occlusion of the Os Uteri and Vagina*, in *American Journ. of Med. Sciences*, July 1848.

Foreign bodies when lodged in the vagina require some skill in extracting them. The most common is the pessary, the strings of which break, and the patient, from ignorance, generally allows it to remain until the discharge becomes most offensive, simulating that from malignant disease. Severe irritation is also set up; and after a time the vagina may become so contracted around it, that it is exceedingly difficult to introduce any instrument to take hold of it. In one case the pessary had to be sawn in two parts, by a saw introduced into the vagina, before it could be removed. In another, a metal pessary was so impacted that the perinæum required division to facilitate its removal. For ordinary cases a forceps made for the purpose is best.

In the *London Medical Gazette*, 1854, p. 264, a case is reported where a broken neck of a bottle was found in the vagina. A point of it had entered the bladder, and on this point a calculus had formed as well as around the part in the vagina. A glass bottle was removed by the writer with polypus forceps. An ale-glass, two inches and a half in diameter and three in height, was removed by the forceps, and the case is reported in the *Lancet*, 1856, vol. ii. p. 451. At Guy's Hospital a case occurred, under the care of Mr. Hilton, in which a flat bone netting-mesh, about ten inches long, was successfully removed from the pelvis of a girl, who had introduced it into that region per vaginam. The length of the mesh necessitated its division into two parts before it was removed. The mesh is in the museum at Guy's Hospital.*

Injuries to the *vulva and external parts* arise from kicks, falls astride, sitting on sharp instruments, rape, and the passage of the child's head. They must be treated upon the ordinary principles of surgery. As these parts contain much connective tissue, they very readily swell after injuries, and suppuration also extends widely and quickly throughout their tissues. As the vascularity of these organs is great, contusions give rise to large extravasations of blood, which cause remarkable discoloration of the skin for some distance around. By the application of cold at first, and subsequently a stimulating lotion, the blood soon becomes absorbed.

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* *Med.-Chir. Trans.* vol. xxxi. p. 315.

Injuries of the perinæum. In the male sex this region is liable to contusions and superficial lacerations. Boys are particularly the subjects of injuries in this part of their bodies, which occur in scrambling over rails or palings; and adults frequently bruise the part by striking it upon the pommel or some other part of the saddle in riding. The result is more or less effusion of blood into the loose connective tissue, and the appearances termed ecchymosis become visible in a day or two. Local pain or tenderness generally accompanies the swelling which results, with slight difficulty and perhaps pain in micturition. Retention of urine sometimes occurs from the mechanical pressure of the swelling upon the urethra, and therefore in children especial care should be observed to ascertain that the bladder is emptied.

Repose, and the local application of warmth and moisture, or a lotion of the liquor plumbi diacetatis dilutus, is usually all the treatment that is required.

Incised and even lacerated wounds of the integuments and deeper tissues of the perinæum usually heal favourably, when treated in the manner applicable to the special case, and therefore their treatment requires no particular description here. The Surgeon should, however, bear in mind the relations of the urethra to this region.

But although the primary results of a wound in the male perineal region cannot be regarded as more serious than other superficial wounds of soft parts, yet the secondary results may involve considerable risk to life. The proximity of the wound to the urethra causes the inflammation resulting from it to extend to that canal, and thus there may be excited, from an apparently trivial cause, all the dangers and difficulties accruing from retention of urine, and the usual means may be required to relieve that condition.

Let the following case illustrate this point.

A rather weak man, twenty-two years old, was admitted into Guy's Hospital in 1838, with a lacerated wound of the perinæum, which penetrated merely to the muscles. The injury had been inlicted by falling off a chair and striking the perinæum. At first a catheter was passed without any difficulty, but by degrees this operation became impeded by surrounding inflammation. The urethra was at last involved in the mischief, and by the introduction of a catheter it was supposed that a false passage was established. The urine escaped into the connective tissue of the perinæum, and a large abscess was the result. The appetite of the patient had entirely failed soon after the accident, and great constitutional disturbance had resulted. At last hectic fever, with colliquative diarrhœa, supervened, and he sunk in sixteen days after the receipt of the injury. Post-mortem examination showed that the tissues of the heart, lungs, liver, and kidneys were diseased. The cavity of a large abscess existed between the bladder and rectum, and into the last viscus there was an opening. The mucous membrane of the bladder and urethra was covered with false membranes, and there were abscesses in the walls of the bladder.

The perinæum in the female sex is liable to a much more serious injury during parturition. Placed behind the vulva, the integuments and subcutaneous tissues are so much stretched during the passage of the child's head, that they are unable to offer sufficient resistance, and they become torn or lacerated. The direction of the rent is either immediately backwards, central, or a little to one side or the other. Should this accident occur, the edges of the wound may be brought together with sutures, and a fair chance of cicatrisation exists. But if neglected, the surfaces heal over, and a permanent fissure will be the result. Even when the torn surfaces are covered with granulations, their suitable adjustment with the quill-suture may induce cicatrisation.*

(C) Injuries of the Rectum and Anus.

Incised wounds of this portion of the alimentary canal usually heal very readily. An illustration of the fact may be taken from the observation of incisions made into the bowel for the cure of fistula in ano, and of those in which the anterior wall of the bowel is incised, to permit the extraction of a large stone from the urinary bladder. Even instances in which the rectum has been accidentally wounded in the lateral operation of lithotomy might be mentioned, to show how readily such wounds heal.

The rectum is sometimes injured by the introduction of bougies, or the ends of enema syringes. In the museum at Guy's Hospital there is a portion of rectum perforated by a bougie. The patient had been affected for many years with stricture, and had often been relieved by surgical aid; at length, in an attempt to pass the bougie himself, he perforated the rectum, and death ensued in about ten hours.

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* See a case in *Guy's Hospital Reports,* 1855, p. 184.

In another case the same injury was inflicted by the introduction of an O'Beirne's tube. The wound was about five inches from the anus. A man, aged sixty-seven, was the subject of strangulated hernia. It was supposed to be reduced, but the symptoms of strangulation continuing, a rectum bougie was passed. Collapse and death followed. After death the rectum was found perforated, as the preparation shows.*

As an effect of perforation, the lower part of the abdomen may become emphysematous. A case of this kind was under the care of the late Dr. Hughes. A man, aged fifty, was admitted into Guy's Hospital in 1856, with cancerous disease of the pylorus. The necropsy revealed ulceration of the rectum, which had occupied nearly the whole of its lower third; the surface of the ulcer was irregular and ragged, and formed irregular bands and pouches. Beneath one of these bands, consisting of muscular fibre, was a small opening into the cellular tissue; this opening the patient had made with an enema syringe, and it had led to emphysema of the whole of the lower half of the abdomen. The preparation is in Guy's Hospital museum.

As a secondary result of wounds of the rectum and anus, peritonitis must be mentioned. If phlegmonous erysipelas attacks the wound, and extends into the connective tissue of the pelvis, the inflammation may reach the reflection of peritonæum passing from the bladder to the rectum. Spreading from this point, it diffuses itself over the whole extent of this serous membrane, and death ensues. This complication is rare, but I have witnessed its occurrence.

Wounds of this region implicating the urinary bladder have been alluded to above. As an unusual result attending the operation of paracentesis vesicæ by the rectum, may be mentioned emphysema, extending to the upper parts of the body.† This complication must be, however, very rare, since it has never occurred once in numerous operations performed in Guy's Hospital.

Foreign bodies in the rectum may be divided into two classes:

1. Those composed of materials which have passed first along the upper part of the alimentary canal.
2. Those introduced at the anus.

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* The preparation is in Guy's Hospital museum.

† Two cases are related in the *Lancet*, January 1860, p. 89.

1. To the first class belong small bones, or pieces of bone; hard bodies, as fruit-stones, which may or may not be covered with accumulations of fæcal matter; large bodies composed of hardened fæces; and concretions of substances taken as medicine, such as masses of magnesia.

The indications of the existence of such foreign bodies as above described are pain in attempts at defæcation; a sense of weight and fulness at the anus, as of something there which cannot pass the orifice; the habitual and often-repeated passage of loose mucous stools, occasionally a little blood; and the development of external hæmorrhoids. By introducing the index-finger a hard solid mass is felt.

Such hard masses require to be removed with care. To accomplish this, the bowel must be well lubricated with oil and warm water injected into the rectum. If these plans fail to dislodge the irritating cause, mechanical means must be employed, first to break the solid body, and then to remove it piecemeal.

2. Foreign bodies introduced per anum are of various kinds. The patient probably being always aware of the nature of the body so impacted above the sphincter ani, will be able to assist the Surgeon who has to extract it, by giving some detail of its structure and form. The Surgeon must then exercise his own ingenuity as to the removal.

JOHN BIRKETT.

INJURIES OF THE UPPER EXTREMITY.

ONE of the principal physical characteristics of man is the extensive development and varied application of the upper extremity. When we consider that it is chiefly by the wonderful power and versatility of movement enjoyed by the hand and arm, that the mandates of his intellectual nature are carried out, and its evidences impressed on the material creation, and moreover, that this member is so situated as to be constantly interposed for the protection of otherwise defenceless vital organs, it will not seem surprising that injuries are met with more frequently in this, than in any other part of the human frame. The greater number of these, of course, present no special characters which distinguish them, either in their nature or treatment, from similar injuries occurring in other parts of the body; hence it will only be necessary in this essay to treat fully of those, the particulars of which depend upon, or are modified by, the anatomical constitution of the part affected.

The frequent and comparatively slight injuries called *bruises* or *contusions*, may be met with in the upper extremity in every variety of severity, but call for no especial remark on their nature and treatment. The same may be said of the effects of intense heat and cold, *burns*, *scalds*, and *frost-bite*. The ends of the fingers are liable to the latter affection under the same circumstances as produce it elsewhere, but, as a general rule, are not so readily attacked as the corresponding parts of the lower extremity.

SPRAINS.

Sprains are very frequent in all the joints of the upper limb, especially in the wrist, and articulations of the thumb, as these parts are much exposed in falls, when the arms are instinctively thrown out to protect the head and chest. The bones being forcibly bent upon one another, if actual dislocation be not produced, a severe strain of the ligaments, often attended with rupture of some of their fibres, will take place. This is not unfrequently followed by inflammation of the synovial membrane and other structures connected with the joint, sometimes of a very intractable nature. Even when the active inflammation is subdued, a relaxed and permanently weakened condition of the part will often remain. Neglect in the early period of the treatment is a frequent cause of the trouble that such injuries give rise to afterwards, it being very difficult to convince patients of the necessity of submitting to the inconvenience of keeping the joint in a complete state of rest, for what seems at first a trifling injury.

The *muscles* appear to be sometimes the seat of sprains. After violent exertion, as rowing, lifting heavy weights, &c., some particular muscle, or group of muscles, is found to be swollen, tender, or perhaps painful, especially when any movement brings it into action. Similar causes occasionally produce *rupture of the muscles*, either entirely or in part. The muscles of the upper extremity in which this has been observed, are the pectoralis major, deltoid, triceps, and more frequently the biceps.

Rupture of tendons is an accident about which much has been written, especially with reference to the long tendon of the biceps, which would appear to be especially obnoxious to this injury. Mr. Callaway[*] has fully described the symptoms attendant upon it, and has collected twenty-two cases, in which on post-mortem examination the upper part of the tendon had apparently been torn; but the researches of more recent pathologists have shown that one of the most constant effects of the not unfrequent disease of the shoulder-joint, called by Dr. R. Adams of Dublin "chronic rheumatic arthritis," is disorganisation and ultimate destruction of the intracapsular portion of this tendon. In the absence, therefore, of any history of injury, and taking into consideration the other pathological changes which were found in the joints examined, the greater part, if not all, of the so-called cases of rupture of the longer tendon of the biceps may reasonably be supposed to have been the result of this disease.[†] In the opinion of the last-named Surgeon, the reported cases of dislocation of the long tendon of the biceps with partial displacement of the head of the humerus upwards,[‡] are also to be classed as the effects of disease, and not of injury; but the proof of this appears to me not quite so satisfactory as in the former cases.

In connexion with this subject, a curious injury may be mentioned, which has been described as *displacement of the inferior angle of the scapula* over the edge of the latissimus dorsi muscle, and is stated to be caused by raising the arm above the head to an unnatural extent. The only fully reported cases that I have been able to collect of any thing analogous to this, are, one by Mr. Banner,* another by Mr. Rose,† and a third, which occurred last year among the out-patients of the Middlesex Hospital, and for the particulars of which I am indebted to Mr. W. H. Rix, at that time house-surgeon. None of these cases, however, exactly corresponded with the description given by Liston;‡ for although the posterior border and inferior angle of the scapula projected very markedly, there was no distinct account of any injury, and the affection seemed rather to be paralysis of the muscles attached to this part of the bone, especially of the serratus magnus. In the last-mentioned case the subject was a delicate-looking girl of fourteen; the whole of the posterior border of the right scapula was very prominent, and seemed to meet the skin covering it, almost at a right angle. The inferior angle only projected a little more than the rest of the border, but the fingers could be passed fairly beneath it. The scapula could easily be pressed into the proper position, but it immediately started back again when left to itself. The motions of the arm were weakened and impaired. The treatment of such cases consists in the application of a bandage round the chest to keep the scapula in place, and galvanism to restore the tone of the affected muscles.

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[*] *Dissertation upon Dislocations and Fractures of the Clavicle and Shoulder-joint*, p. 144.

[†] See R. Adams' *Treatise on Rheumatic Gout*, 1857, and art. "Abnormal Conditions of the Shoulder-joint," in *Cyclop. Anat. and Phys.*; R. W. Smith, *Dublin Quarterly Journal of Medical Science*, Feb. 1853; E. Canton, *Lond. Med. Gazette*, 1849, vol. viii. p. 958.

[‡] See a paper by J. Soden jun., *Med.-Chir. Trans.* vol. xxiv. 1841.

WOUNDS.

The hand and arm, from their frequent exposure, are liable to every kind of wound, nearly all of which are amenable to the ordinary modes of treatment. All varieties of poisoned wounds are of course more often met with here than elsewhere, though their frequency is exaggerated, in consequence of whitlows and other local manifestations of peculiar constitutional conditions being generally attributed by the sufferers from them, to such an origin. When, from whatever cause, suppuration has taken place in the hand or fingers, the importance of early and free evacuation of the pus cannot be too strongly insisted upon, as it is often confined beneath the dense fasciæ, and being thus prevented from reaching the surface, extends along the course of the tendons, causing extensive disorganisation of all the tissues, and frequently terminating in sloughing of the tendons, or necrosis of some of the phalangeal bones.

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* *Trans. Prov. Med. and Surg. Association*, vol. xi. 1842.

† *Lond. Med. Gazette*, vol. xlv. 1850.

‡ *Elements of Surgery*, 1832, part iii. p. 321.

According to M. Nélaton, abscesses of the fore-arm develop themselves most commonly after wounds or inflammations of the thumb, or little finger, "rarely after wounds of the other three fingers; and the anatomy of the parts, which shows that the sheaths of the flexors of those fingers do not communicate with the sheath under the annular ligament under the wrist, explains the reason."* The same Surgeon also remarks, that in examining for pus in this part, it is necessary to make palpation in the long diameter of the limb; as, if the fingers are placed transversely, the sensation caused by the displacement of the muscles is very deceptive. If the abscess is deeply seated, in order to obtain a free opening, and to avoid wounding nerves, vessels, or tendons, M. Nélaton directs that an incision should first be made through the skin three inches in length, then the aponeurosis slit open upon a director over an interstice between two muscles; the latter may then be separated, and the opening enlarged, if necessary, by introducing the end of the finger.

Needles often run into, and break off in, the hand, causing sometimes much trouble in extraction, especially if the piece be small, and have penetrated deeply into fleshy parts, as the ball of the thumb. The position of the foreign body must be ascertained as well as possible, by searching for the wound by which it entered, and by carefully feeling for its ends through the skin. If its situation can be ascertained with tolerable certainty by these means, it must be cut down upon, and drawn out with the forceps; but care must be taken not to drive it further in during the attempt at extraction, and all unnecessary or speculative incisions in a part so well supplied with nerves and vessels as the palm of the hand must be avoided. Time and some suffering is saved to the patient, if it can be found and extracted at once; but if, after a thorough examination, it cannot be discovered, a poultice may be applied, and it will probably present itself near the surface in a few days.

Lacerated wounds about the hand are the cases commonly supposed to be especially liable to be followed by tetanus: yet I think that if we examine the assigned causes of many cases of traumatic tetanus, allowing for the great comparative frequency of such injuries, we shall hardly find that wounds of the hand bear any disproportionate ratio to those of other parts.

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* *Clinical Lectures on Surgery*, edited by Walter F. Atlee, M.D. Philadelphia, 1855.

In incised and punctured wounds inflicted by carpenters' tools or knives accidentally slipping from the hand, or by broken glass, the radial or ulnar arteries are not unfrequently divided near the wrist; but the treatment will be conducted entirely in accordance with the general principles applicable to wounded arteries. See vol. i. p. 689.

The bleeding from wounds of the deep palmar arch is apt to be very troublesome, on account of the difficulty often experienced in finding the divided extremities of a vessel placed at a considerable depth from the surface, close to the bone, and in a wound which, owing to its anatomical relations, cannot be freely enlarged. Therefore, in this case it is necessary sometimes to depart from the rule, almost universal elsewhere, of tying the vessel at the seat of injury, and to seek some other method of restraining the hæmorrhage. In the first place, a graduated compress should be laid over the wound: this is kept in position by two small wooden splints placed transversely across the hand, one on the palmar and one on the dorsal side, a good pad of lint being placed beneath the latter, while the former rests upon the compress; they may then be brought together to any degree of tightness, by strips of adhesive plaster round their extremities. Then the current of blood through the radial and ulnar arteries should be restrained, either by pieces of thick bougie, or by small rollers laid lengthwise over the course of the vessels in the lower part of the fore-arm, and confined by a bandage. A third larger roller, placed between the others, is often a useful adjunct in keeping these in place, by preventing the bandage from forcing them towards each other. Extreme flexion of the elbow, which checks the flow through the brachial artery, is preferred by some Surgeons. The patient should, if possible, be kept in bed, with the hand tied up to the bed-post, so as to raise it well above the level of the rest of the body. If secondary hæmorrhage come on, the compress must be taken off, the wound well cleansed from clots, &c., and the apparatus re-adjusted. Experience and reflection alone will teach to what extent, and for how long, pressure may be applied to the wound without fear of producing sloughing of the tissues. If these means fail to stay the bleeding, ligature of the arteries of the fore-arm in their lower third, or of the brachial a little below its middle, must be adopted. Opinions are much divided as to which is the preferable operation. Most Surgeons use the latter only as a *dernier ressort;* while others, finding that if both radial and ulnar are tied, circulation in the hand is still maintained by the interosseous artery, which is secured with difficulty, prefer the single and simpler proceeding of at once tying the brachial.

Severe lacerated wounds, with or without fracture, as well as wounds of joints, should be treated according to general principles, recollecting, however, that such injuries are endured and recovered from, far more readily in the upper, than in the corresponding parts of the lower extremity. Not only is the reparative power more active, but there is also the advantage of their not requiring the patient to be confined to bed, with consequent deterioration of general health, during the whole of the treatment. Numerous instances of most severe compound fractures and dislocations implicating the elbow or wrist joint, which at first sight appeared hopeless, have by careful treatment completely recovered.

The records of military surgery will furnish many such. As a good example of the extent of reparative power, when aided by judicious treatment, I may quote one related by Sir James Prior, Deputy-Inspector of Hospitals and Fleets,* which occurred in civil practice. A man, aged thirty-four, working in a dock-yard, received a violent blow from the rapidly-revolving handle of a windlass, on the under side of the left arm, at the elbow-joint. "There was a large wound on the under surface of the joint, occasioning a general disconnexion of its parts, muscular and otherwise, excepting immediately in front. All the ligaments also were obviously torn asunder; the heads of the radius and ulna were driven wholly from their situations, upwards and forwards on the humerus; the condyles of the latter bone, and part of its shaft, to the extent of two and a half or three inches, projected behind from the wound at nearly a right angle with the fore-arm, and as thoroughly denuded of all ligaments and muscular attachments as if cleaned with the scalpel." The brachial artery and nerves of the arm being uninjured, it was determined to attempt to save the limb. The bones were easily reduced, the wound carefully brought together, and treated with cold applications. The patient eventually recovered with a very efficient limb, and went back to his laborious employment.

Primary amputation is very rarely required in cases of compound fracture or dislocation involving the elbow-joint, never, indeed, unless the artery be torn through, or the soft parts in front as well as behind the joint extensively damaged. In treating such injuries, the position most favourable and convenient to the patient, that of semi-flexion, should be adopted, the arm being fixed immovably on a gutta-percha splint, which may be cut away, opposite the wound, so as to allow of the application of the dressings; and the fracture or dislocation being reduced, and any loose fragments of bone removed, the edges of the wound should be brought together as neatly as possible with wire sutures, and treated with cold applications, especially irrigation if there be much inflammatory action. When the bones are much comminuted, and the external wound is small, it is best to enlarge it freely, and excise the injured ends of the bone, as much less constitutional disturbance follows cases so treated, and a false joint with a very considerable amount of motion will be formed.* Wounds of the wrist-joint should be treated on the same principles, the fore-arm and hand being fixed upon a straight splint.

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* *Lancet*, December 1844.

Compound fractures of the humerus, if attended with much laceration of soft parts, especially lesion of the artery and of the great nervous cords, sometimes require amputation; but the fore-arm when similarly injured may almost always be preserved.

The hand is very frequently the subject of extensive crushes, involving bones as well as soft parts, and often requiring the removal of one or more of the fingers or of the whole member. Great ingenuity may be displayed in the performance of the operation in such cases, the Surgeon being guided in the amount to be removed and the selection of flaps by the extent of the injury, always remembering the necessity of saving as much as possible. The loss of one or two fingers is not of great moment, except in some peculiar occupations; but the thumb is of especial importance, and if only a single finger is left to oppose it, great use may still be made of the hand. It is even better to save the thumb alone, or a single finger, when it can be done, than to sacrifice the whole hand. Although every thing that is likely to be of service must be carefully preserved, the opposite error must be avoided of attempting to save, at a great sacrifice of time to the patient, a severely injured finger, which, although it may ultimately heal, will remain permanently stiff or deformed, and which, from its being either useless or positively interfering with his employment, may eventually have to be removed. Among people of the upper classes of life, even elegance of appearance is an element of consideration. On the latter account, when a finger has to be removed entire, the head of the metacarpal bone, although uninjured, is often taken out with it, so that the remaining fingers come nearer together, and the loss is less conspicuous; but with working people, this should not be done, as to them a broad palm is often an advantage; and the hand is weakened by the division of the transverse ligament which connects the head of the bones. In compound dislocations of the phalanges, in which attempts at reduction have been unsuccessful, it is better to remove the projecting head of the displaced bone, then to bring the wound together, and fix the finger on a splint, trusting to the formation of a ligamentous joint.

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* See an interesting series of severe injuries to the elbow-joint, in London and Provincial Hospitals, collected by Mr. J. Hutchinson, *Med. Times and Gazette*, 1856, vol. ii.

Statistics of Fractures and Dislocations of the Upper Extremity.

Nearly all statistical information hitherto published regarding fractures and dislocations is more or less unsatisfactory, either because the numbers given are too limited, or the cases being selected, they do not present a fair average of all ages and classes of the population.

The following table has the advantage of showing nearly every case which presented itself during a given period at a hospital so situated as to afford a fair example of the ordinary accidents of civil life in this country. Some few have been rejected on account of insufficiency of diagnosis, or omission of age or sex from the record, and doubtless the remainder are not entirely free from errors; such errors, however, correct themselves when the numbers are sufficiently large. In one class only is there a considerable defect, viz. the fractures of the phalanges; many cases that are vaguely entered in the hospital books as "smashed" or "crushed" fingers, without specification of lesion to bone, having been omitted from the table. If all these were added, the numbers assigned to this injury would probably be doubled.

It is not within the scope of a work like the present, to discuss all the inferences that might be derived from the study of this table. A few general observations on the influence of sex and age upon the production of these injuries, will, however, be admissible.

It will be seen, as might be expected from the difference of habits and occupation, that the whole number of males exceeds that of females, the ratio being that of 10 to 6·2; but this ratio is not constant in all kinds of injury, and at all periods of life. During infancy there are 200 males and 197 females; so that, as might be supposed, in this period the liability to these accidents is the same in both sexes. This age is characterised by the great frequency of fracture of the clavicle, more than half of the entire number of injuries belonging to this bone. The bones of the fore-arm and humerus follow next in order; but fractures of the olecranon, meta-

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Fractures and Dislocations of the Bones of the Upper Extremity, treated at the Middlesex Hospital, during ten years ending February 28th, 1861.

A. Fractures.

	Age. 0 to 5.		Age. 5 to 15.		Age. 15 to 30.		Age. 30 to 45.		Age. 45 to 60.		Age. Above 60.		Total.		
	Sex.		Sex.		Sex.		Sex.		Sex.		Sex.		Sex.		M. and F.
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
Scapula	5	2	1	0	0	1	9	3	5	0	1	0	21	6	27
Clavicle . . .	114	110	54	31	35	17	42	20	37	22	9	6	291	206	497
Humerus: Upper end .	0	3	5	1	4	0	8	4	4	0	3	5	24	13	37
Humerus: Shaft . . .	20	14	26	12	20	16	15	12	3	9	3	7	87	70	157
Humerus: Lower end	6	1	25	1	10	2	2	0	2	1	1	1	46	6	52
Olecranon . . .	1	0	4	1	17	3	9	5	7	4	4	5	42	18	61
Ulna alone (excluding Olecranon) . .	6	6	16	1	3	4	12	8	10	6	2	4	49	29	78
Radius alone . .	29	44	58	11	53	27	48	41	27	81	14	60	229	264	493
Both Ulna and Radius . .	16	12	47	9	10	4	4	6	5	8	3	6	85	45	130
Metacarpal bones	1	1	6	1	41	8	37	9	8	0	2	0	95	19	113
Phalanges . . .	1	1	24	5	35	8	30	11	17	4	4	1	111	30	141
Total . .	199	194	266	73	228	90	216	119	125	135	46	95	1080	706	1786

B. Dislocations.

	Age. 0 to 5.		Age. 5 to 15.		Age. 15 to 30.		Age. 30 to 45.		Age. 45 to 60.		Age. Above 60.		Total.		
	Sex.		Sex.		Sex.		Sex.		Sex.		Sex.		Sex.		M and F.
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
Clavicle . . .	0	0	1	1	0	0	2	0	0	1	1	0	4	2	6
Acromion . . .	0	0	0	0	3	0	3	1	2	1	0	0	8	2	10
Humerus . . .	1	1	0	0	16	6	38	13	25	16	28	15	108	51	159
Elbow	0	1	25	3	5	1	5	3	2	0	0	0	37	8	45
Thumb	0	1	6	1	8	1	16	5	10	7	2	1	42	16	58
Phalanges of Fingers . .	0	0	4	2	6	1	5	8	2	5	1	3	18	19	37
Total . . .	1	3	36	7	38	9	69	30	41	30	32	19	217	98	315
Fractures and Dislocations .	200	197	302	80	266	99	285	149	166	165	78	114	1297	804	2101

carpus and phalanges, and all dislocations, are almost unknown. During the succeeding ten years we find the active disposition of boys exposing them to frequent fractures of the clavicle, humerus, and fore-arm, and to dislocations of the elbow-joint; while with the opposite sex such accidents are comparatively less frequent than at any other period, the proportion being now as 10 to 2·7. In the next period, that from fifteen to twenty years, the males exceed the females in the proportion of 10 to 3·7, and this excess steadily decreases, till, between forty-five and sixty, the sexes figure in nearly equal numbers; and beyond that age the liability to these accidents is considerably greater among women than among men, this preponderance being almost entirely owing to the great frequency among the former, of fracture of a particular part of one bone, viz. the lower end of the radius.

Further reference to the numbers in the table will be found under the head of each particular injury.

FRACTURES OF THE BONES OF THE UPPER EXTREMITY.

Fractures of the Clavicle.

The clavicle is more frequently broken than any other bone in the body, the radius excepted. Although met with at all ages, this accident is most common in infancy and early childhood; nearly one half of the entire number of cases recorded in the above table occurred before the completion of the fifth year. Up to this period its relative frequency in the different sexes is nearly equal; at all subsequent ages men are much more liable to it than women.

Sometimes the fracture is caused by direct application of force to the bone, as by a heavy blow, or a wheel passing over it, or a fall in which the body of the bone comes into contact with some hard substance; but much more commonly it is due to indirect violence, as falls on the point of the shoulder, or on the hand when the arm is outstretched; in the latter case the shock is transmitted through the other bones to this, the last in the series, which being fixed at its proximal end to the sternum, must give way under a sufficient amount of force. Dr. F. H. Hamilton has collected six cases of fracture of the clavicle from muscular action.*

The bone is generally broken near the middle, although it may be towards the acromial, or more rarely the sternal extremity. The line of fracture is said to be usually transverse, but in many specimens that I have examined in museums, it has passed in a straight line from the deepest part of the concavity of one curve to that of the other, and therefore very obliquely across the shaft of the bone, and inclining from within upwards, so that the inner fragment overlaps the outer. The part between the two curves is generally the weakest part of the bone, and hence more liable to fracture. When the clavicle is broken near its middle, the inner fragment is usually retained in its place, because the strong ligaments attached to its sternal end prevent much movement, and the muscles connected with it nearly counterbalance each other. There is, however, a slight tendency to elevation of the outer end, which in cases left long neglected becomes very marked. I lately saw a girl, aged nine, who had broken her clavicle a month before, and had had no treatment: the sternal fragment projected upwards at an angle of 45°, its sharp extremity forming a visible prominence in the side of the neck. The other fragment was fully an inch below this, and connected with it by what appeared to be a band of fibrous tissue, passing nearly vertically between them.* The outer fragment usually falls below its normal position, owing to the weight of the arm, and it is drawn inwards by the muscles passing from the chest to the shoulder and humerus, the outer end being turned somewhat forwards; its broken end is, in the great majority of cases, placed beneath that of the sternal fragment, though it occasionally, but very rarely, is found above† or anterior‡ to it. If the fracture is oblique, the fragments generally ride, and the whole bone is somewhat shortened. The diminution in length of clavicles that have united after oblique fractures is sometimes more than an inch.

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* *A Practical Treatise on Fractures and Dislocations*, Philadelphia, 1860, p. 180.

The signs usually presented are very characteristic, and, except in the case of young fat children, there is rarely much difficulty in the diagnosis. There is pain at the seat of injury; the patient is unable to lift the arm to the head, or to move it extensively forwards or backwards, at least without much suffering; his neck and head are usually inclined to the injured side; while, to relieve the pain caused by the displaced fragments of bone, he will often support the elbow with the opposite hand. The point of the shoulder falls lower than the other, and somewhat forwards and inwards, its distance from the centre of the sternum being diminished in proportion to the amount of riding of the broken fragments. On passing the finger along the upper border of the clavicle, the abrupt projecting end of the inner fragment and the depression of the outer one are easily recognised, and manipulation will prove the separation of the fragments, and generally produce crepitus, though the latter important sign is sometimes not perceived until the broken ends are brought into apposition by extending and drawing back the shoulders. The differences in position of the bone mentioned above will of course produce corresponding modifications of these signs. In transverse fractures, the amount of displacement is often inconsiderable; but pain, loss of power, mobility of the fragments, and crepitus, will indicate the nature of the injury.

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* See also the figure at p. 219 in Dr. R. W. Smith's *Treatise on Fractures in the vicinity of Joints, &c.* Dublin, 1847.

† Malgaigne, *Traité des Fractures et des Luxations.* Paris, 1847, tome i. p. 468.

‡ Lonsdale, *Practical Treatise on Fractures*, 1838, p. 208.

Fracture of the sternal extremity of the clavicle is a very rare accident. Lonsdale,* relating the case of a child three years old, in which the clavicle was fractured about half an inch from the sternum, conjectures that such cases arise from separation of the epiphysis. This, however, clearly cannot be, as the epiphysis at the sternal end of the clavicle is an extremely thin plate of bone, and commencing to ossify at about the age of eighteen, is joined to the bone a few years later; if, then, such an injury could happen, it would be only at this particular period of life. Blandin† describes a case in which the clavicle was fractured between the costo-clavicular and sterno-clavicular ligaments, without displacement; but in the only two specimens of similar fracture that Malgaigne‡ could find in the Musée Dupuytren, the external fragment was displaced considerably downwards and forwards.

Fractures of the acromial extremity of the clavicle are much more frequent than the last. R. W. Smith § has shown, from examination of specimens of bones after death, that the outer end of the clavicle may be broken, either between the conoid and trapezoid portions of the coraco-clavicular ligament, or between this ligament and the acromio-clavicular articulation. In the former situation the fracture is of comparatively rare occurrence, and attended with scarcely any displacement of either fragment of the bone; in the latter, on the contrary, there is generally a considerable amount of displacement of the outer fragment; its inner end being drawn upwards and outwards by the action of the clavicular portion of the trapezius muscle, while the outer or articulating surface is directed downwards and inwards by the weight of the arm, and the action of the muscles passing from the chest to the shoulder. This displacement is sometimes carried so far that in some of the cases examined, the outer fragment had united to the other at a right angle.* The inner fragment is not materially altered in position unless the coraco-clavicular ligament be ruptured.

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* Op. cit. p. 206.

† *Gazette des Hôpitaux*, 22 avril 1845.

‡ Op. cit. tom. i. p. 491.

§ Op. cit. p. 209.

An *incomplete fracture* of the body of the clavicle, sometimes attended with *bending* of the bone, is occasionally met with in children. Vide FRACTURES, vol. i. p. 761.

Comminuted fractures of the clavicle are not unfrequently the result of direct violence, and are easily recognised by the great mobility of the fragments.

Compound fractures of the clavicle are extremely rare; and notwithstanding its vicinity to the large vessels and nerves of the neck, serious complications from implication of the soft parts do not often follow fractures of this bone. Among the severe injuries which occasioned the death of the late Sir Robert Peel, was "a comminuted fracture of the left clavicle, below which a swelling as large as the hand could cover, and which pulsated synchronously with the contractions of the auricles of the heart, formed." This was evidently the result of a wound of some large vein, probably the subclavian, by the broken ends of the bone. From the intense pain suffered, it was also conjectured that some of the nerves of the axillary plexus were lacerated.† In the museum of St. George's Hospital is a specimen in which the fractured end of the bone was driven through the internal jugular vein. The patient, a boy æt. 13, had been standing under a tree in a storm, and was struck by a falling branch. Several cases are also on record of injury to the brachial plexus of nerves, followed by paralysis of the arm.

Fracture of both clavicles in the same subject sometimes occurs. Malgaigne could only collect five cases. A man, aged 47, was admitted a few years ago into the Middlesex Hospital with ununited fracture of both clavicles, occasioned by the same injury. Want of union is very uncommon; in this case it was probably owing to the difficulty of restraining the motion of both arms at the same time during the treatment; as a general rule, no bone in the body unites more readily.

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* This observation is corroborated by a recent specimen exhibited by Mr. Canton to the Pathological Society, Nov. 6th, 1860.

† *Lancet*, July 6th, 1850.

Treatment. Although the indications to be followed in the treatment of fractured clavicle are plain enough, the numerous contrivances that have been invented for the purpose, and the diversity of the methods adopted in different countries, and by different Surgeons, are sufficient to show the difficulties that are practically found in carrying them out. As Dr. F. H. Hamilton says, "a catalogue of the names only of the men who have upon this single point exercised their ingenuity would be formidable, nor would it present any mean array of talent and of practical skill."

The most certain method to insure union without deformity, is to keep the patient lying on the back in bed until the fracture has united, the head being fixed to the pillow, and both arms confined to the side of the body. This plan may be adopted in the case of young ladies who wear low dresses, and in whom it is consequently particularly desirable to preserve the symmetry of the clavicles; but men and boys will seldom be found to submit to the confinement, and it is satisfactory to know that the amount of shortening which almost invariably follows an oblique fracture, treated in the usual way, will rarely interfere in any appreciable degree with the perfect use of the arm.

Presuming that the ordinary displacement has occurred, to restore the outer fragment to its normal position, the shoulder must be drawn outwards, upwards, and backwards. For a description of the many, more or less complicated, forms of apparatus invented to retain the parts in this position, the reader is referred to special treatises upon the subject, as they have nearly all met with but a very limited or local application, and without figures any account of them would be unintelligible. As the results of the method of treatment generally followed at most of the hospitals in London are as satisfactory as those attributed to any of the others, and as there is in it the great advantage of requiring no other materials than those which are at all times at the command of the Surgeon, I shall content myself with describing it. A stout wedge-shaped pad, with the broad end upwards, stuffed with tow or horse-hair, and having a little cotton-wool wrapped around it, is placed well up in the axilla. Then the elbow is brought close to the side, and the forearm laid across the front of the chest, the hand being raised towards the opposite shoulder. It is now to be firmly bound in this position with a broad calico roller, some of the turns of which are made to pass beneath the elbow and over the opposite shoulder, so as to act as a sling, and raise the humerus. The bandages should be secured by a few stitches.* Some Surgeons advance the elbow, others think that it should be directed somewhat backwards, but an intermediate position is more generally preferred. Very frequently, before the elbow is fixed, a figure-of-eight bandage is placed round the shoulders, and tied tightly behind, with the intention of drawing backwards the extremity of the clavicle; but this is by many, and with much justice, objected to, on the ground that, unless put on with very great care, it may press upon the inner end of the distal fragment and push it behind and below the other, thus adding to the deformity which it is intended to prevent. The axillary pad, which was introduced by Desault as a fulcrum by which the clavicle may be extended when the elbow is pressed to the side, is now generally used of smaller size than was originally proposed, and is discarded altogether by some Surgeons, on account of its liability to compress the axillary vessels and nerves. The apparatus is then reduced to little more than a sling for the elbow.

It is evident from these differences of opinion, that in the management of fractured clavicle, as in that of any other similar injury, no one rule ought to be followed. Careful attention to the peculiarities of the individual case will alone suggest the particulars of the treatment that should be adopted; and whatever may be the apparatus determined upon, it should be frequently examined, in order to be sure that the intention with which it is applied is really being carried out, and that no parts of it have become loose or disarranged, or, on the other hand, are unnecessarily tight, so as to give pain or chafe the skin.

If the fracture is attended with complications, or if both clavicles are broken, it is advisable to confine the patient to bed.

Union usually takes place in about three weeks, in young subjects even earlier.

Fractures of the Scapula.

As this bone is not, like the clavicle or other long bones of the arm, placed between resisting points, it can scarcely be affected by any application of indirect violence; and as its peculiar conformation and protected situation afford it considerable immunity from direct injury, it is very rarely broken. The shape of the scapula is so very irregular, that fractures occurring in its different parts present special characters, and require therefore separate consideration.

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* Bandages stiffened with starch, dextrine, or plaster of Paris, are often used with great advantage.

1. *Fracture of the body of the scapula* may occur in combination with other injuries when the trunk is severely crushed, as by the fall of a heavy weight upon it. It has also been caused by a blow applied directly, the passage of a cart-wheel over it, or a fall backwards, in which the bone is struck against some hard substance, such as the corner of a table.

The fracture usually runs transversely or obliquely across the flat part of the body of the bone beneath the spine; a vertical fracture has also been described extending through the spine, or the bone may be variously starred or comminuted. An incomplete fracture through the spine alone, or one of the margins, appears to be sometimes met with; and occasionally the thin central portion of the infra-spinous fossa is fissured, or even deeply indented, while the borders, being thicker and stronger, have escaped injury. There is often but little displacement of the fragments; sometimes, however, one or the other of the broken edges may be felt to project. In a man aged forty-three, lately a patient at the Middlesex Hospital, the body of the scapula was broken by a carriage-wheel passing over his back; he was so extremely thin, that the nature of the injury could be ascertained with perfect facility. The line of fracture extended from the anterior costa, one inch above the inferior angle, upwards and backwards to the posterior costa, just below the root of the spine. The triangular portion thus separated was drawn directly upwards under the other, and became united there; so that the scapula was eventually one inch shorter than the other, and had the lower end deeply notched. There is a specimen in Guy's Hospital museum* in which the line of fracture is almost the same, but the inferior fragment has united on the dorsal surface of the other. The different direction of the displacement of the fragment in these instances was probably communicated to it at the moment when the injury was inflicted, while the drawing upwards was due to the combined action of the muscles attached to it.

Mobility can generally be detected by grasping the shoulder and upper part of the scapula with one hand, and the lower part of the bone near the inferior angle with the other; crepitus will also be obtained in this manner, or by placing the hand flat upon the dorsum of the scapula, and moving the humerus in various directions. But great care must be taken not to mistake that pseudo-crepitus which appears to be caused by the movement of the tendons over the shoulder-joint for a bony crepitus ; a mistake not unfrequently made by inexperienced Surgeons when examining injuries about the shoulder. In muscular and fat subjects, and where there is little displacement, the diagnosis of these fractures is often attended with difficulty, but in others the signs are sufficiently obvious. Malgaigne recommends that in making the examination, the fore-arm should be brought behind the back, and the hand raised as much as possible, as by these means the inner border of the scapula will be rendered prominent.

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* No. 1097, ^{70}.

Treatment. The fragments having been reduced as completely as possible by manipulation, a broad bandage or strip of adhesive plaster should be placed round the upper part of the chest, so as to confine the body of the scapula. The motions of the arm are then to be restrained and the elbow raised, by supporting it in a sling. When there is much displacement, it is difficult to keep the fragments in good apposition by the application of compresses, or any of the other contrivances that have been suggested for the purpose ; but in most cases union takes place readily, and although there may be some deformity, the arm regains its proper motions.

2. *Fracture of the acromion process.* The acromion process being the most prominent part of the shoulder, it is liable to be broken across when a blow is received directly from above, in falls upon the shoulder, and also perhaps by upward pressure of the head of the humerus, in falls on the elbow or hand. The frequency of this accident has been overrated, as many of the numerous specimens found in museums of what appear at first sight to be old ununited fractures of the acromion, are probably examples of non-union of the epiphysis.* There seems to be some as yet unexplained connexion between this condition and the disease called chronic rheumatic arthritis of the shoulder-joint, as they are often found associated.† For this reason, little dependence can be placed upon the statement, founded on the examination of such specimens, that after fractured acromion the union is always of a ligamentous character.

The fracture usually extends directly across the process, separating a larger or smaller portion from the rest of the bone. Sometimes it is only the extreme tip beyond the clavicular articulation which is broken off. Occasionally there is no displacement, the detached fragment being held in its place by the periosteum, but generally it is drawn downwards and a little forwards, by the action of the deltoid and weight of the arm.

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* F. H. Hamilton, op. cit. p. 211.

† R. Adams, op. cit. p. 107.

The symptoms are, pain in the injured part, with loss of power in moving the arm, especially upwards. The shoulder has lost somewhat its rounded form, its extremity being sunk. On passing the finger along the spine of the scapula towards the acromion, a sudden depression is felt at the seat of fracture, and mobility of the process itself can be perceived. On raising the arm so as to bring the fragments in apposition, all the abnormal appearances are lost, and crepitus, which is absent as long as the arm hangs down, can now be obtained.

Treatment. The principal indication is to support the elbow, so that the acromion may be raised by the head of the humerus; this is accomplished by a sling, which must be made to give more support to the elbow than to the fore-arm, allowing the hand to drop. More perfect apposition can be obtained if a pad be placed between the side and the elbow, so as to keep the latter away from the body, and inclined a little backwards. The arm should then be fixed by a roller passed round the chest, and kept in this position for about four weeks.

3. *Fracture of the coracoid process* is an extremely rare accident, and only produced by severe direct violence; it is usually accompanied by other injuries, as dislocation of the humerus, in the cases reported by South* and Holmes,† or by fracture of other parts of the scapula. If the coracoid process alone is broken off, the three muscles attached to its extremity would tend to draw it downwards and inwards; but while the strong coraco-clavicular ligaments remain entire, the displacement cannot be very great. In an uncomplicated case, there is no alteration in the shape of the shoulder, the principal diagnostic signs being crepitus and the mobility of the fragment, discovered by manipulation.

The treatment consists in supporting the arm in a sling, with the elbow advanced upon the front of the chest, so as to keep the muscles inserted into the process relaxed, and as much at rest as possible.

4. *Fractures of the neck of the scapula, and of the glenoid fossa.* It is the opinion of most modern writers on surgery, that simple fracture across the anatomical neck of the scapula never occurs. There is no specimen exhibiting it in any of the museums in London,

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* *Med.-Chir. Trans.* vol. xxii. p. 100.

† Ibid. vol. xli. p. 447.

and Hamilton says that he has not been able to find one in any of the American cabinets. There are several cases on record of fracture through what has been called the surgical neck, *i. e.* the narrow part of the bone, opposite the notch in the superior costa, the coracoid process being included in the separated portion. In all of those with which I am acquainted, there has been also a general comminution of the body of the bone. One specimen is in the museum of Guy's Hospital;* another, in which repair has taken place, in the museum of the Royal College of Surgeons; and the well-known case reported by Du Verney,† where the injury was occasioned by a fall into a stone-quarry, forms a third example. The three cases related by Sir Astley Cooper, and various others which have appeared more recently in the journals, of "fracture of the neck of the scapula," were founded only on diagnosis made during life. They are, therefore, not entirely to be relied upon, especially as it has been shown by Malgaigne that most of the symptoms usually assigned to this injury might be produced by a dislocation of the humerus into the axilla, with fracture of a portion of the margin of the glenoid fossa.

The last-named accident is not very uncommon; the inner border is more frequently the seat of injury, but fractures have been found running across the glenoid fossa, and even splitting it up into several portions. In a case which I believed to be one of this kind, admitted June 25, 1860, into the Middlesex Hospital, there was a distinct bony crepitus accompanying subcoracoid dislocation of the humerus. The latter when reduced almost immediately reappeared, and as the spasm of the muscles by which this was occasioned increased after every reduction, it constantly became more difficult both to replace the bone, and when replaced to keep it in position. The patient was then brought completely under the influence of chloroform, a large pad fixed in the axilla, and the elbow bound close to the side and raised. By these means the humerus was retained perfectly in place, and no subsequent difficulty was experienced during the treatment. At the end of three weeks the bandages were removed, and passive motion commenced in the joint.

Fractures of the Humerus.

The fractures to which this bone is liable may be conveniently divided into three groups, viz. (A) those affecting the upper extremity, or that part which is situated above the surgical neck of the bone; (B) those of the shaft; and (C) those of the lower articular extremity.

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* No. 1097, ^{85}.

† *Traité des Maladies des Os*, 1751, tom. i. p. 227.

The injuries belonging to the first group, although of less frequent occurrence than either of the others, demand the fullest attention of the Surgeon, as they present considerable difficulties both of diagnosis and treatment. In the following account of them, I have availed myself largely of the valuable essay upon the subject by Dr. R. W. Smith, of Dublin.*

A. *Fractures of the upper end of the humerus* are usually produced by direct violence, as severe blows, or more frequently falls, in which the shoulder comes in direct and violent contact with the ground or some hard substance. Sometimes, however, they appear to have been caused by falls upon the elbow or hand. The point at which the fracture occurs may be (1) the anatomical neck of the bone; (2) the line of junction of the epiphysis with the shaft, *i. e.* immediately below the tuberosities; or (3) a little lower down, at that part of the bone called the surgical neck. A fourth form of fracture in this neighbourhood is the separation of the greater tuberosity from the remainder of the bone. As the capsular ligament of the scapulo-humeral articulation is attached just below the anatomical neck, the first of these fractures is intracapsular, the others are all extracapsular; an important distinction, both as regards their symptoms and prognosis.

1. *Fracture at the anatomical neck of the humerus.* A glance at the form of this part of the bone will be sufficient to show that fracture here must be a rare accident; yet sufficiently numerous specimens are to be found in museums, and post-mortem examinations are on record to establish the claims of this injury to a place in surgical pathology. Displacement of the separated fragment cannot be caused by the action of muscles, as none are inserted into it; but not unfrequently, from the violence with which the shaft is driven against it, the head, lying loose in the capsule of the joint, slips off the shallow glenoid fossa, is forced through the capsule into the axilla, or sometimes is even turned completely round, so that the cartilaginous surface is in contact with the fractured end of the lower fragment. Cases are recorded in which it has united in this, and other almost equally remarkable positions.†

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* Op. cit. chap. iv. p. 176.

† R. W. Smith, op. cit. p. 194; Malgaigne, op. cit. tom. i. p. 529; Sir A. Cooper, *Treatise on Dislocations, and on Fractures of the Joints*, edited by Bransby Cooper, 1842, p. 417.

If the head of the humerus is completely separated, it may remain as a foreign body in the joint, and may then perish from want of nutrition, and be eliminated by suppurative action, unless previously removed by operation. Ligamentous and even osseous union has been met with in some cases; but in these the separation has probably not been entire, portions of the capsule attached to the upper fragment having maintained its vitality. The reparative action is, as might be supposed, chiefly accomplished by the lower fragment, which often throws out bony spicula to such an extent as to form a complete cup surrounding the head.* It not unfrequently happens that the head of the bone is impacted in the cancellated structure of the thick upper end of the humerus, between the tuberosities. This condition is far more favourable for osseous union than the former, though of course it must occasion some permanent deformity of the joint.

The signs of fracture of the anatomical neck without impaction are not very obvious, unless the head of the bone be much displaced; in fact, pain at the seat of injury, some impairment of motion, and crepitus, with absence of the characteristic signs of other fractures in this neighbourhood, are the only evidences to be depended on. In impacted intracapsular fracture, according to R. W. Smith, "the arm is slightly shortened, the acromion process projects more than natural, and the shoulder has lost to a certain extent its rounded form, the upper extremity of the shaft of the humerus is approximated to the acromion, and the entire of the globular head of the bone cannot be felt. In consequence of the fracture of the tuberosity (which often accompanies impaction of the head of the bone), crepitus can be readily detected, when the shoulder is grasped with moderate firmness and the arm rotated."

2. *Fracture at the line of junction of the epiphysis.* As the large epiphysis at the upper end of the humerus, which includes the head and the two tuberosities, is usually united with the remainder of the bone at the age of twenty, it is only in youth or early manhood that we can expect to meet with this injury. At these periods its occurrence is not unfrequent. The upper fragment remains in the glenoid cavity, the superior end of the lower one is drawn inwards by the action of the muscles passing from the chest to the humerus, forming a marked projection situated beneath the coracoid process; but, owing to the breadth of the bone at this part, it is almost impossible that the two broken surfaces should leave each

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* Sir A. Cooper, op. cit. p. 428; R. W. Smith, op. cit. p. 190.

other so completely as to cause any riding, and consequent diminution in the length of the arm.

The following are the signs presented by this injury: the axis of the humerus is directed upwards, inwards, and forwards; the elbow, however, projects but little from the side; the head of the bone can be distinctly felt in the glenoid cavity, and it remains motionless when the shaft is rotated. The projection above spoken of, formed by the upper end of the diaphysis, does not present the sharp irregular margin of an ordinary fracture; on the contrary, it feels rounded, and its superior surface is smooth and slightly convex. "By pressing this part outwards, and directing the elbow inwards during extension and counter-extension, crepitus can be perceived, and the deformity removed without much difficulty; but the moment the parts are abandoned to the uncontrolled action of the muscles, the deformity recurs." (Smith.) The same author observes, that "there is no fracture incidental to the upper end of the humerus in which it is more difficult to maintain the fragments in their proper relative position."

3. *Fracture of the surgical neck of the humerus.* This is the most common of all the fractures in this region. The part of the bone implicated is that between the tuberosities, and the insertion of the pectoralis major and latissimus dorsi muscles. The line of fracture is generally transverse, but it may be oblique. The amount of displacement of the fragments varies considerably. In characteristic examples the upper fragment is tilted upwards and outwards by the action of the muscles inserted into the great tuberosity, the lower fragment is drawn inwards towards the axilla, by those inserted into the bicipital groove, while the various muscles which pass from the scapula to the humerus tend to draw it upwards, an effect which will be greatly facilitated if the line of fracture is oblique. The upper end of the lower fragment has occasionally been observed to project anteriorly, externally, and even posteriorly,*—differences depending probably upon the direction of the line of fracture, and also upon the direction from which the violence causing the injury proceeded. Impaction of the broken ends frequently occurs, in which case (contrary to what obtains in fracture of the anatomical neck) the lower fragment usually penetrates into the cancellous structure of the superior.

In impacted fracture there is very little alteration in the form of the limb, and the signs are remarkably obscure, and chiefly of a negative character. The usual signs accompanying non-impacted fracture are as follows. There is no flattening beneath the acromion, the head of the bone remaining in the glenoid cavity, where it can be felt lying motionless when the arm is rotated; the prominence caused by the upper end of the lower fragment can also be readily detected. This is rendered more distinct, and is felt to move with the rest of the bone, when the elbow is pushed up and rotated; the mobility of the shaft of the humerus is very free, and crepitus distinct, when extension is made. There is usually much pain shooting down the fingers, from the irritation of the axillary plexus of nerves, increased of course by all attempts at motion.

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* Malgaigne, op. cit. tom. i. p. 516.

Treatment of fractures of the neck of the humerus. The treatment is the same in principle for all the above fractures; its details will be guided, to a great extent, by the amount and nature of the displacement.

If impaction has occurred, it is very undesirable to disengage the ends of the bone, as this condition greatly facilitates union, especially in the intracapsular variety. The arm should merely be bandaged to the side, the fore-arm supported in a sling, the swelling and inflammation reduced by the application of cold lotions; and, as R. W. Smith observes, "the prudent Surgeon will never omit to announce to the patient, that a certain degree of impairment of the motions of the joint will be a permanent result of the injury."

In the ordinary fracture of the surgical neck, the method usually followed (almost the same as that described by Sir A. Cooper) is, to place a pad in the axilla to act upon the upper end of the shaft, with small straight wooden splints behind and in front, or a single one on the outside of the arm; to bandage the elbow to the side; and to support the hand in a sling, letting the elbow hang, so that the weight of the arm may tend to overcome the action of the muscles which raise the lower fragment. A gutta-percha cap, moulded to the shoulder, and extending down the outside of the arm nearly to the elbow, is a convenient substitute for the splints. Another plan, recommended by Erichsen,* answers well in some cases: a leather splint, about two feet long by six inches broad, is bent upon itself in the middle, so that one half of it may be applied lengthwise to the chest, and the other half to the inside of the injured arm; the angle formed by the bend, which should be somewhat rounded and well padded, being pressed up into the axilla.

Passive motion should be employed as soon as union is effected, which, according to Sir A. Cooper, is in about one month in youth, but requires from two months to twenty weeks in old age. Malgaigne allows from thirty to thirty-five days as the period at which passive motion should be commenced, in ordinary cases. The same author also gives the important advice, that the elbow, wrist, and finger-joints should be kept in exercise throughout the treatment, as by this means some of the stiffness, which always follows the confinement and want of use of these articulations, will be obviated.

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* *Science and Art of Surgery*, 3d edit. p. 231.

4. *Fracture of the greater tuberosity* is not at all uncommon in connexion with dislocation of the head of the humerus forwards, when the detached process is either drawn backwards by the action of the three muscles inserted into it, and lies in the glenoid fossa of the scapula, or is retained in connexion with the humerus by unbroken portions of the periosteum or capsular ligament.*

This fracture has been said to occur alone, being caused either by direct violence, or sudden action of the posterior scapular muscles. R. W. Smith has given a detailed account of the symptoms and pathology of this accident, as observed in two cases, in one of which a post-mortem examination was obtained. In both of these, however, there appears to me to have been an actual dislocation of the head of the humerus, beneath the coracoid process, which must be looked upon as the primary abnormal condition, and the fracture of the tuberosity only as a concurrent circumstance; unless, indeed, it could be supposed that the action of the subscapularis muscle, when deprived of its usual antagonists, could be sufficient to displace the humerus to the extent indicated.†

B. *Fractures of the shaft of the humerus.* The humerus is broken very much more frequently in some part of its shaft than in either extremity; the seat of the fracture being more often below than above the middle of the bone.

The common causes are either direct violence or falls on the hand or elbow. Many well-authenticated cases are on record in which it has been produced by muscular action alone. These cases have generally occurred in the act of throwing a stone or ball, striking a blow, suddenly seizing some support while falling, or in a practice formerly frequent, of trying the strength of the arm, in which two men rest the elbows on a table, place the palms of the hands in contact, and each endeavours to press his adversary's hand down. A case of this kind was described, as long ago as 1791, by Debeaumarchef; and Lonsdale reports two as occurring under his own observation at the Middlesex Hospital. Numerous examples of fracture of the humerus from muscular action are collected by Malgaigne;* and others have appeared more recently in the journals.† In some of these there probably existed a previous condition of the bone which rendered it particularly susceptible to fracture; but in most of them there seems no reason to suspect that it was otherwise than perfectly healthy.

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* See page 569.

† Malgaigne does not recognise "fracture of the greater tuberosity" as a distinct injury, and cites Smith's cases as examples of true "intracoracoid" luxation of the humerus. Op. cit. tom. ii. p. 518.

The line of fracture is usually transverse, but it may be oblique. In the latter case it may pass in any direction, though perhaps most often from above, downwards and outwards. Transverse fractures are usually attended with little or no displacement; when oblique, the position of the fractured extremities is determined by the direction of the line of fracture. The principal effect of muscular action is to approximate the extremities of the bone, and thus produce riding of the fragments and shortening of the limb. The deltoid, however, tends to tilt upwards and outwards that part of the humerus into which it is inserted: hence surgical writers frequently make a distinction between the fractures above, and those below the insertion of this muscle; in the former, the fractured end of the upper fragment inclines inwards, and that of the lower, outwards; in the latter, the end of the upper fragment projects outwards, and the lower inwards—a distinction, however, of not much practical importance. Shortening of the limb does not generally take place to any great extent, as the actions of the muscles have a counterpoise in the weight of the lower part of the arm.

The signs of fracture of the shaft of the humerus are obvious, and the diagnosis is unattended with difficulty. There is pain, loss of power in the arm, and usually some deformity; and as the two portions can easily be grasped separately, their mobility is readily ascertained, and crepitus produced. Simple fractures without displacement generally unite favourably; yet, according to the commonly received opinion, there is no bone so subject to ununited fracture, and the formation of false joint, as the humerus. The statistical tables drawn out by Norris show an equal liability in the femur.* Twenty-five to thirty days are usually required to effect consolidation in young subjects, and thirty-five to forty in adults. (Malgaigne.)

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* Op. cit. tom. i. pp. 531 et seq.

† See *Med. Times and Gazette*, 1857, 2d vol. pp. 85 and 254.

Treatment. In ordinary cases, after the fractured ends are brought into apposition, by extension if necessary, four small, straight, well-padded wooden splints should be applied, one on each side of the humerus; the elbow bent at a right angle, and allowed to hang down, while the hand is supported in a sling. The splints should be so narrow as not to overlap each other, and must be confined in their place by straps and buckles, or broad strips of adhesive plaster. The starched bandage or gutta-percha will often be found a useful substitute. If the fracture is very oblique, and attended with much displacement from muscular action, although the weight of the arm aids us somewhat, some further permanent extension is frequently required, in order to avoid deformity of the limb. Much may be done by careful management of the splints and pads, arranging them so as to press the projecting parts into place; something also may be accomplished in the way of extension by the splint on the inside of the arm (the top of which is well padded) being made to press into the axilla on the one hand, and against the upper edge of the inner condyle on the other; this plan, however, must be regulated with care, otherwise the pressure of the upper end upon the axillary veins is apt to cause the arm to swell. Unfortunately all the mechanical contrivances which have hitherto been invented for the purpose of effecting extension, are more or less open to objections, and have fallen into disuse almost as soon as they have been made public.

C. *Fractures of the lower end of the humerus.* While fractures of the shaft of the humerus are met with in not very dissimilar proportions in both sexes, and at all ages, those of the class now under consideration occur chiefly among young men and boys, with whom also dislocations at the elbow-joint are most frequent.

The fractures of this part of the bone may be divided, as in the upper end, into those that are external to the joint, and those which implicate the synovial membrane. To the first class belong, fracture of the humerus just above the condyles; separation of the lower epiphysis; and fracture of the projecting point of the internal condyle (called by the French the "epitrochlea," by Hamilton "internal epicondyle"). In the second division are, transverse fracture of the lower end of the humerus with a vertical fissure extending through the lower fragment, so that the condyles are separated both from each other and from the shaft; and an oblique fracture separating one or other of the condyles with a contiguous portion of the articular surface, from the rest of the bone.

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* See vol. i. p. 793.

1. *Fracture across the shaft of the humerus at its lower end* ("*fracture sus-condylienne*," Malgaigne), immediately above the condyles, where it is expanded laterally, and is very thin in the antero-posterior direction, is not an uncommon accident at any age, although in childhood and youth a separation of the lower articular epiphysis will be more likely to occur under the circumstances which would occasion this injury. The most common cause of this, as well as of all the other fractures in this situation, is a fall upon the elbow while bent. The line of fracture is sometimes transverse, though more often oblique from before upwards; but it may run in the reverse direction, or even slant laterally.

The nature and amount of deformity are determined by the direction of the line of fracture, and also sometimes by the mode in which the injury is inflicted. The powerful action of the muscles passing from the upper arm to the fore-arm usually causes a great tendency to shortening and riding of the fragments. In most cases the lower one is drawn backwards and upwards by the triceps, producing an appearance similar to that caused by dislocation of both bones of the fore-arm backwards. The olecranon projects unnaturally, there is a hollow above it, and corresponding to this in front of the arm, a prominence formed by the lower end of the shaft of the humerus. The motions of the elbow and fore-arm are more or less impaired, though there is not that absolute immobility that is met with in dislocation. As a mode of distinction between this fracture and dislocation of the fore-arm, Sir A. Cooper gives "the removal of all marks of dislocation on extension, and their return as soon as extension is discontinued," as well as the crepitus detected on rotating the fore-arm upon the elbow; but as fracture of the coronoid process might produce signs similar to these, the following diagnostic characters, dependent upon the fact of the condyles and articular portion of the humerus being displaced with the bones of the fore-arm, are important: "The projection of the olecranon posteriorly is not more distant from the condyles of the humerus than in the natural condition, if there is fracture, but it is much more so in dislocation; also in fracture the anterior projection is not so broad and rounded, and is *above* the fold of the elbow, while in luxation it is much below it. It may be added that, in measuring the arm from the acromion to the prominence of the internal condyle, a shortening will be found in fracture which does not exist in luxation" (Malgaigne).

Treatment. Extension, made by grasping the humerus with one hand, and the fore-arm with the other, will in general suffice to bring the fragments into proper apposition. To retain them so, the elbow should be fixed at a right angle on a jointed wooden splint, or, what is more convenient, a gutta-percha splint moulded to the parts while they are in good position, and extending along the posterior surface of the upper arm, behind the elbow, and under the fore-arm and hand, so as to give good support to the latter. In addition to this, a small straight wooden splint should be fixed in front of the arm, its lower extremity resting on a pad placed over the projecting end of the shaft of the humerus, and firmly strapped to the larger splint. This arrangement may of course be varied, according to the inclination of the displacement of the fractured portions of bone. Passive motion should be commenced in about three weeks, otherwise the elbow-joint will become rigid.

A larger or smaller portion of the *inner condyle* (*epitrochlea*) may be broken off without implicating the articular end of the bone. Attention was first directed to this injury by Granger.* It may be occasioned by muscular action, or more commonly by direct falls upon the inner side of the elbow. The detached portion is usually drawn somewhat downwards by the action of the muscles arising from it. Impairment of the motion of the limb, the mobility of the fragment, and the crepitus, will suffice to distinguish the nature of the accident, unless the swelling is very great. A complication sometimes arises from injury to the ulnar nerve. In the treatment, the elbow, as well as the wrist and fingers, should be semiflexed, so as to relax the muscles which arise from the inner condyle. The injured fragment can seldom be retained perfectly in place; but though some deformity may remain, the movements of the elbow are generally but little interfered with. Passive motion should be resorted to early.

2. The remaining fractures of the lower end of the humerus are of a more serious character, as they are necessarily attended with more or less inflammation of the joint, and are consequently almost always followed by some permanent impairment in the movements of the elbow. If the great swelling which frequently comes on after these injuries should mask the nature of the fracture, it will be best to keep the arm at rest, laying it on a pillow, if the patient can be

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* *Edin. Med. and Surg. Journal*, vol. xiv. p. 196.

kept in bed, or lightly confined by an angular splint, and treated with evaporating lotions, and other antiphlogistic measures, as the case may demand, until, by the subsidence of the inflammatory action and swelling, the exact seat of the injury will become apparent.

The symptoms of the first-named of these injuries resemble those of a fracture across the lower end of the shaft of the humerus. The separation of the condyles from each other may be ascertained by grasping and moving them backwards and forwards, when, unless the swelling and effusion into the joint are very great, crepitus will be obtained.

A single fracture, extending obliquely from either the outer or inner side of the humerus, just above the condylar projection, downwards into the joint, and displacing more or less of the articular surface of the bone with the condyle, is commonly spoken of as *fracture of the outer* or *inner condyle*, as the case may be. Of these, according to Malgaigne, the former is most common; but my experience decidedly leads me to agree with South* and others, that the latter is most frequently met with.

The amount of displacement depends upon the size of the piece broken off, and the continuity of its ligamentous connexions. If these remain tolerably intact, scarcely any deformity ensues. The best diagnostic sign is obtained by grasping the projection of the injured condyle between the finger and thumb, when it will be found to move separately from the rest of the bone; crepitus will also be usually produced in this way, as well as by rotating the radius, if it be the external, or by flexing and extending the ulna, if it be the internal condyle.

In the *treatment* of the above injuries, the elbow should be bent at a right angle, and fixed by a jointed wooden splint, or the gutta-percha apparatus recommended above for fractures of the lower end of the shaft of the humerus. Sir A. Cooper advises that passive motion should be commenced at the expiration of three weeks after the accident in the child, and at a month in the adult. This practice has been followed by most English Surgeons. Malgaigne begins to move the joint on the twentieth day. The following rules, given by Dr. F. H. Hamilton, deserve consideration: "Within seven days, and perhaps earlier, passive motion must be commenced, and perseveringly employed from day to day, until the cure is accomplished; indeed, in a majority of cases, it is better not to resume the use of splints after this period; for although at this time no bony union has taken place, yet the effusions have somewhat steadied the fragments, and the danger of displacement is lessened, while the prevention of ankylosis demands very early and continued motion."*

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* Trans. of *Chelius's Surgery*, vol. i. p. 557.

A very severe crush, such as might be occasioned by the passage of a heavy body over the joint, may produce even greater complication of fracture than any of the above, but this is uncommon unless there be an external wound also. For the treatment of compound fractures of the elbow-joint, see p. 522.

Fractures of the Bones of the Fore-arm.

A. *In the vicinity of the elbow-joint.*—1. *Fracture of the olecranon.* This injury is much more frequently met with in men than in women, and principally during middle life. Before the age of fifteen it is almost unknown. It is generally caused by a fall upon the back of the elbow when bent, or by a direct blow; but a sudden contraction of the triceps muscle has been said to produce it. The portion that is separated varies in extent, from a mere shell of bone to the whole of the process. The fragment may be retained in its place by its strong ligamentous connexions and periosteum, but it is more frequently drawn away from the remainder of the bone by the action of the triceps, to the extent of from half an inch to an inch and a half; the interval being increased when the arm is bent. The power of motion in the arm, especially of extension, is very much impaired. If the fragment is separated, the diagnosis is usually made without difficulty. On tracing the subcutaneous border of the ulna backwards, a distinct depression is felt at the elbow, above which the detached olecranon, easily movable from side to side, can be felt. Crepitus cannot be produced unless, on extending the fore-arm, the fractured surfaces can be brought into contact with one another.

The fragment unites usually by ligament only; but perfect osseous union does occasionally occur, of which we have proof in a case reported by Mr. F. D. Fletcher, of a boy aged sixteen, who fractured both olecranons, and whose death ten months afterwards afforded an opportunity of examining the state of the injured parts. The displacement had not been very great.†

Treatment. The main indication is to keep the triceps relaxed; the next, to endeavour by mechanical means to maintain the detached portion in its normal situation. To effect the former, the arm is to be kept extended. The flexed position of the elbow, used in all other fractures about the joint, is quite inadmissible in fractures of the olecranon. Generally, a straight wooden splint, well padded, is fixed along the front of the arm; but gutta-percha has the advantage, not only of accurately adapting itself to all the inequalities in the form of the limb, but also, owing to its possessing a slight degree of elasticity, is more comfortable. It should extend from the upper part of the arm to the wrist, and be fixed by two or three bands of adhesive plaster. To fulfil the second indication, which is only necessary when the displacement is great, a roller should be placed upon the arm, from the fingers upwards, and where it comes to the elbow, it may be made, by a figure-of-eight arrangement, to press the top of the olecranon downwards. Sir A. Cooper recommends that a piece of linen bandage be placed longitudinally on each side of the joint; over these, wetted rollers are to be applied round the arm, one above and another below the elbow; the extremities of the linen are then to be doubled down over the rollers, and tightly tied, so as to cause their approximation. In a month the splint should be removed, and passive motion commenced, but with great caution, as bending the elbow necessarily puts the newly-united part on the stretch.

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* Op. cit. p. 262.

† *Medical Times and Gazette*, 1851, vol. ii. p. 173.

As this fracture usually extends into the joint, and is in most cases occasioned by direct violence, some inflammation of the synovial membrane will necessarily take place. Too great action should, however, be guarded against, by the usual antiphlogistic treatment; and if it proceeds to such an extent as to threaten ankylosis, the extended condition of the arm should be relaxed, so that the elbow may become fixed in the position most convenient and useful to the patient.

2. *Fracture of the coronoid process of the ulna* is said to occur in onnexion with dislocation of the radius and ulna backwards, and also to be sometimes met with without that complication. The ases that have been reported in which it has been observed in the iving subject are all more or less unsatisfactory, and have differed onsiderably in the symptoms which they presented. I have been ble to meet with but three or four specimens and recorded post-mortem examinations of this injury; one of the former is in the museum of Guy's Hospital.* Another case is that of a man killed

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* No. 1119 ^{25}.

by a fall from the roof of St. George's Hospital, in whom the coronoid processes were found to be fractured, and the two bones of the fore-arm dislocated backwards on both sides. The specimens are now preserved in the museum of the Hospital.* Dr. F. H. Hamilton, after a careful analysis of all the published cases, arrives at the conclusion that this injury is extremely rare.†

Should the nature of the accident be recognised, the most appropriate treatment will be to keep the arm at rest in the flexed position, so as to relax the brachialis anticus muscle. In about a month passive motion may be gently commenced.

3. *Fracture of the neck of the radius.* Surgical authors differ considerably in their estimate of the comparative frequency of this injury, the result chiefly of the difficulty of making an absolutely certain diagnosis during life. South says, that it "is not an uncommon accident, and very liable to be confused with dislocation of the bone forwards on the outer condyle of the upper arm. It is accompanied with much distortion and swelling, and, being naturally deeply imbedded in the muscles, is difficult to make out satisfactorily. The head of the bone must be grasped with the thumb and finger of one hand, whilst the other draws the lower end of the bone from it, by pulling at the hand alone; and then, upon rotation, if there be fracture, the crepitation will be felt."‡ The post-mortem proof of such a fracture is, however, almost entirely wanting. As the head of the bone is an epiphysis, and does not unite until the age of puberty, we should expect to find its separation from the shaft more common before that age than at any other period of life.

Malgaigne reports two cases in which a post-mortem examination showed a fracture extending through the head of the radius, both of them in combination with other severe injuries to the neighbourhood of the joint. In the two specimens of fracture of the coronoid process referred to above in the museum of St. George's Hospital, the head of the radius was also split longitudinally.

B. *Fractures of the middle of the fore-arm.*—1. *Fracture of both radius and ulna.* The two bones are broken together at this situation more frequently than is either the ulna or radius alone. Direct violence is the most common cause; a blow, the passage of a wheel over the arm, or a fall in which some hard substance is struck. In the numerous cases of fracture of the fore-arm occasioned by falls upon the hand, it is almost always the radius, which receives the shock directly from the carpus, that is broken, the ulna not often participating in the injury. Malgaigne relates a case of fracture of both bones of the fore-arm from muscular action, occurring while digging; the only one on record, as far as I am aware, from this cause.

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* Series iii. subseries 2. g, nos. 4, 5.

† Op. cit. p. 299.

‡ Transl. of *Chelius*, vol. i. p. 559.

The most frequent seat of fracture is about the middle or lower third; the upper part being, from its situation, and its more complete muscular covering, less exposed to injury than the more distant. The line of fracture is usually transverse, or nearly so; it is often at the same level in the two bones, or if not, generally higher in the radius than in the ulna. The nature and amount of displacement of the fragments vary much; it may be almost or quite absent; but usually both bones will be bent at an obtuse angle, either forwards, backwards, or on one side; or one only may be bent, its broken ends falling in towards the companion bone. Oblique fractures are generally accompanied by a riding of the fragments, and shortening, more or less marked, of the limb. In transverse fractures, it is not common for the faces of the broken extremities to separate completely, so as to allow them to overlap each other; but this happens sometimes, and the overlapping may be in different directions in the two bones, the lower fragment of the radius being in front of the upper, and that of the ulna behind, or *vice versâ*. Incomplete, or "greenstick," fracture of the bones of the fore-arm are very frequently met with in children.

The diagnosis is usually simple; the pain and loss of power, the unnatural bend in the arm, the separate mobility of the upper and lower parts, and the crepitus, are signs which indicate the nature of the accident. These fractures are often troublesome to manage, the fragments having a great tendency to become displaced, and so permanent mal-position of the bones, causing loss of rotation of the fore-arm, is not an infrequent result. The power of rotation is even sometimes lost, in cases where the bones have united in tolerably good position, from deposits of new osseous matter taking place between them, and soldering them together, or, as Lonsdale* suggests, from the upper and lower fragment of the radius being in a different position as regards supination at the period of union; the former being completely supinated by the action of the muscles attached to it, while the latter, in the usual method of treatment, is kept in a semi-prone position; hence, after union, complete supination of the hand becomes impossible. I have found a proof of the truth of this conjecture in an examination of numerous specimens of united fractures of the radius, in the greater number of which the lower fragment was much less supinated than the upper.* Want of union is another and more distressing result, which occasionally follows this fracture. To guard against such untoward events, the splints and bandages have often to be applied tightly, in consequence of which a still greater evil, gangrene of the extremity, has occurred more frequently in this than in any other injury of a similar nature, especially in children.

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* Op. cit. p. 125, and *Lond. Med. Gazette*, vol. ix. 1832.

Treatment. If there is much displacement and shortening, reduction must be effected by extension applied at the wrist, while counter-extension is made at the elbow, the fore-arm and fingers being semi-flexed to relax the muscles; at the same time, the broken ends may be brought into proper apposition by manipulation. The position in which the fore-arm is now to be placed has long been a subject of controversy among Surgeons. Although the state midway between pronation and supination, which is most comfortable to the patient, is generally adopted, yet when the fragments are much displaced, and have a tendency to fall together and diminish the interosseous space, complete supination, recommended by Lonsdale, for the reasons above mentioned, and more recently advocated by Malgaigne, is better adapted to produce a satisfactory result.

The objectionable plan of tightly bandaging the limb before putting on the splints, is now justly discarded by most Surgeons, on the ground that it prevents the fulfilment of the important indication of keeping the two bones apart. On the contrary, a graduated compress is generally placed lengthwise behind and in front, between the radius and ulna, at the seat of injury, so as to press into the interosseous spaces; over these, straight wooden splints, extending from the elbow to a little beyond the wrist, are fixed, and the fore-arm is suspended in a sling. These compresses have been objected to, as likely to interfere with the circulation of the limb, and, if the splints are properly padded, may generally be dispensed with. It is important that the splints should be fully as wide, or somewhat wider, than the limb, so that the bandages which retain them in place exercise no lateral pressure upon the bones.

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* See especially preps. nos. 2950 and 2951 in Mus. Roy. Coll. Surg.

2. *Fracture of the shaft of the ulna* is almost always caused by direct violence, either in striking against some hard body, as the corner of a door-step in falling, or when the fore-arm is elevated to ward a blow from the head, in which position the ulnar side is turned forwards. The middle and lower portions are most commonly the seat of fracture; the superior strength and thickness of the upper, and its less exposed position, rendering it little liable to injury. Displacement, when it occurs, affects the lower fragment only, the other being retained in its situation by the articulation at the elbow; it may be in any direction, determined by that from which the force acting on it proceeds. If there is no displacement, the appearances of bruising and the swelling and pain will mark the point of injury. Mobility of the lower fragment and crepitus may generally be obtained by holding the upper part firmly, and pressing the lower towards the radius. The subcutaneous position of the greater part of the bone adds greatly to the facility of diagnosis. The radius, acting as a kind of splint, prevents shortening, and assists in keeping the parts in apposition; so that the treatment of this fracture is much less difficult than where both bones are broken. Care should be particularly taken that the broken ends do not incline towards the radius, so as afterwards to impede the rotation of the fore-arm. If there is much tendency to this, pads should be placed between the bones, and the supine position adopted; in other cases, that midway between supination and pronation will be the best. The splints should be straight, one anterior and one posterior; or the starched bandage or gutta-percha may be used. The fore-arm and hand should be supported in a sling.

3. *Fracture of the shaft of the radius.* Though the radius is broken more frequently than any other bone of the body, this preponderance is chiefly due to the great number of fractures of its lower end, the middle part being probably not more subject to this injury than the same portion of the ulna. It is occasionally, but very rarely, broken immediately below the insertion of the tendon of the biceps into the tuberosity; an accident which has been, though improperly, described as "fracture of the *neck* of the radius."*

Direct violence is the most common cause of fracture of the shaft of the radius, although it may be occasioned by a fall upon the hand. The diagnosis is usually unattended with difficulty, the principal signs being, loss of power of rotation, mobility, and crepitus elicited by pressing the fragments in different directions with the fingers, or on fixing the upper one, and rotating the hand.

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* See two cases by Mr. J. Moore, *Lond. Med. Gaz.* vol. xxxvi., 1845, p. 1079.

The broken ends have a tendency to fall inwards towards the ulna, and so to diminish the interosseous space. This must be guarded against by pads, as directed when speaking of fracture of both bones; the hand should also be supinated; and the general treatment recommended in the next section for fractures of the lower end may be adopted.

C. *Fractures of the bones of the fore-arm in the vicinity of the wrist-joint.*—1. *Fracture of the inferior extremity of the radius.* Excepting perhaps the middle of the clavicle, there is no single point of the skeleton so frequently the subject of fracture as the lower end of the radius; the reason being, that in falling down, the hands are generally thrown forwards, and the whole weight of the body received upon the palmar aspect of the carpus, from which it is directly transmitted to the broad articular surface of the radius; this bone, placed thus between the weight and momentum of the body in falling on the one hand, and the resistance of the ground on the other, gives way at its weakest point, viz. where it commences to expand into the broad articular extremity composed of cancellated tissue, covered with a compact layer much thinner than that of the shaft. The cause, then, of this injury is almost always indirect violence; it may, however, be occasioned by a direct blow, or a wheel passing over the arm; but in such accidents both bones usually suffer. Although met with frequently in both sexes, and at all periods of life, it is a remarkable circumstance, that while up to the age of thirty it is more prevalent among men, yet after middle life the reverse takes place, and as age advances this disproportion between the sexes continues to increase; so that among old women, fracture of the lower end of the radius is more frequent than all other fractures and dislocations of the upper extremity taken together.

The pathology of this fracture has been the subject of many special memoirs, and even of much controversy. The earliest accurate description which appeared of it in our language is by Colles of Dublin;* hence it is frequently designated by surgical writers as "Colles' fracture." It has more recently been the subject of an elaborate memoir by R. W. Smith[*] of the same city; and on the Continent it has attracted the attention of Pouteau,[†] Desault,[‡] Dupuytren,[§] Goyrand,[‖] Diday,[¶] Voillemier,[**] Malgaigne,[††] and others.

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* *Edin. Med. and Surg. Journal,* April 1814.

The line of the fracture is almost always transverse, occasionally it crosses obliquely from side to side; it is usually situated from half an inch to one inch above the articular surface of the bone. In some instances there is scarcely any displacement, but most commonly the lower fragment assumes a peculiar position with respect to the other, which gives a very marked and characteristic appearance to the limb. In the great majority of cases, this displacement is backwards, and somewhat upwards; so that in bones in which unreduced fractures of this kind have consolidated, the posterior surface is found to be considerably shortened, while the anterior retains its normal length. The carpal articular surface also, besides occupying a position more posterior than normal, as regards the shaft, has an inclination backwards, instead of forwards, as in the usual state. So that in fact the inferior fragment has undergone a sort of rotation on its transverse axis, a "mouvement de bascule," as the French term it. This change of position is, however, modified by the strong ligaments of the lower radio-ulnar articulation (which do not usually give way) confining the inner side of the fragment more in place than the outer, so that the displacement is more extensive on the side of the styloid process, and the outer border of the bone is shortened to a greater degree than the other; hence it is that the whole hand, which follows the movements of this fragment, is inclined towards the radial side. It is difficult to conceive that this displacement can be effected in any other way than by a penetration of the posterior surface of the superior fragment into the soft cancellous structure of the inferior; an explanation suggested by Voillemier, and adopted with slight modifications by Malgaigne, Nélaton, and Erichsen, but opposed by R. W. Smith, whose opinion is, that, as a rule, no such penetration takes place, "the distortion being the result of the combined action of the supinator longus, the extensors of the thumb, and the radial extensors of the carpus." After a full consideration of the elaborate arguments which have been brought forward on either side to determine this point, it appears to me that the evidence from the examination of specimens of bones in which union has taken place, as well as that derived from the symptoms during life, shows that impaction occurs in a large number of cases, although it cannot be denied that muscular action frequently aids in maintaining the peculiar deformity.* The question can only be finally decided by a greater number of careful dissections of recent cases, for which opportunities very rarely occur. Sometimes the inferior fragment is split into several pieces, apparently from the force with which the lower end of the shaft has penetrated it.

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[*] *Treatise on Fractures in the vicinity of Joints*, 1847, p. 129.

[†] *Œuvres Posthumes*, 1783, tom. ii. p. 251.

[‡] *Œuvres Chirurgicales*, 1813, tom. i. p. 155.

[§] *Leçons Orales*, 1834, tom. iv. p. 161.

[‖] *Gazette Médicale*, 1832, p. 664, and *Journal Hebdomadaire*, Feb. 1836.

[¶] *Archiv. Gén. de Médecine*, 1837, 3^{me} série, tom. i. p. 141.

[**] Ibid. 1842, tom. xiii. p. 261.

[††] Op. cit. tom. i. p. 603; *Gaz. Méd.* 1832, p. 730.

The symptoms of this injury are so pronounced, that it may almost always be recognised at first sight. The patient is unable to perform the motions of supination and pronation, and complains of much pain, especially about the internal lateral ligament of the wrist, which is put upon the stretch. The hand being articulated to the displaced fragment of the radius, is carried with it backwards and towards the radial side; the styloid process of the ulna is thus rendered extremely prominent. The lower end of the radius forms a marked projection on the dorsum of the wrist, and there is a corresponding depression in front. Often in the first instance this portion is not movable upon the shaft, and there is no crepitus; but after disengaging the impacted ends by powerful extension, both these distinctive signs are usually obtained. If there is much swelling from inflammatory effusion, the distinctive characters will be more or less masked; but now that the nature of the injury is so well understood, it will be next to impossible to mistake it, as was formerly frequently done, for dislocation of the carpus backwards, which, by the way, is an extremely rare accident.

In young subjects, fractures of the lower end of the radius are easily reduced, unite readily, and leave the use of the limb perfectly unimpaired; but in old persons, who, as before stated, are especially liable to this injury, the result is often most unsatisfactory, even after the greatest care has been used during the treatment. It is frequently months before the hand is free from pain, and regains it proper motions, and too often an unsightly, crooked, and permanently stiff wrist remains, to the great inconvenience of the patient, and annoyance of the Surgeon.

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* Dr. Smith says, "In the descriptive Catalogue of the Pathological Museum of St. Bartholomew's Hospital, published in 1846, the same error" (that of attributing the deformity to impaction), "as it appears to me, has been committed. See no. 78, p. 133, and no. 94, p. 136." An inspection of the specimens referred to has left no doubt on my mind that the description in the Catalogue is perfectly correct.

Treatment. If the fracture is impacted, extension, while the hand is supinated and adducted as much as possible, is generally required to unlock the ends of the bones. After this is accomplished, there is still a great tendency to displacement from muscular action, which must be overcome as far as possible by mechanical means. Many Surgeons use what is called the "pistol-shaped splint," well padded, and fixed along the back of the fore-arm and hand, so as to keep the latter firmly drawn to the ulnar side, by which means some amount of extension is made upon the lower end of the radius. Another splint, shorter and straight, is adapted to the front of the fore-arm, its lower end resting on a pad which presses on the projecting inferior extremity of the shaft of the radius. According to Dr. F. H. Hamilton, most American Surgeons apply the curved splint to the palmar surface, and the shorter straight splint to the dorsal side of the fore-arm. They also flex the fingers over a hand-block, or pad, attached to the former. A single straight splint along the back or front of the fore-arm and hand, is used by some Surgeons; while others prefer two straight splints, placed one on each side, with pads so contrived as to press the lower fragment of the radius into place, while the hand is left free, and, being unsustained by the sling which supports the fore-arm, hangs down (to the ulnar side) by its own weight. The advantage gained by this method is, that much of the stiffness of the wrist and fingers, which follows their close confinement in the ordinary method, may be avoided. With very old people, this rigidity often gives so much trouble afterwards, that Velpeau considers it best in such cases to dispense with splints altogether, and merely place the arm upon a pillow.

Many arguments for and against the adducted position of the hand, in the treatment of fractures of the lower end of the radius, have been brought forward. The just view of the subject is probably intermediate between that of its extreme advocates and of those who altogether deny its utility. It is, I think, more advantageous in fractures three or four inches above the articulation than in the cases now under consideration; but in practice I have found little difference in the results of the treatment by the straight or pistol-shaped splint. Much more depends upon the care and accuracy with which the minor details are carried out.

The splints should be removed between the third and fourth weeks, and the fingers exercised as much as possible, to overcome their stiffness. There often remains a swelling on the front of the wrist, caused by an indurated condition of the sheaths of the tendons; this must be treated by friction with stimulating liniments, or the application of tincture of iodine.

It occasionally, though very rarely, happens that the lower fragment of the radius is displaced *forwards*. The cause of this injury is said to be a fall upon the back of the hand.*

In subjects under the age of twenty, separation of the inferior epiphysis of the radius commonly takes the place of fracture of this part. The symptoms and treatment in both cases are very nearly identical.

2. *Both radius and ulna* may be broken close to their lower ends; an injury presenting at first sight much more the appearance of dislocation of the carpus backwards than does fracture of the radius alone, as there is now no lateral displacement of the hand, and consequent prominence of the styloid process of the ulna. Careful attention to the exact seat of the injury will enable the Surgeon to form a correct diagnosis. (See p. 584.)

3. Lastly, *the lower end or styloid process of the ulna* alone may be the seat of a fracture, caused usually by violence applied directly.

Fractures of the Bones of the Hand.

1. *Fracture of the carpal bones.* The form and mode of articulation of the bones of the carpus render them very little liable to fracture, except where there has been great violence, as from machinery, or gun-shot, in which cases the soft parts are also extensively injured. (See page 523.) Simple fractures do, however, occasionally occur, from the passage of heavy weights, as cart-wheels, over the hand, or blows and falls on the wrist. Owing to the fragments being retained in their place by their numerous ligamentous connexions with the surrounding bones, there are few symptoms beyond those that might be ascribed to a severe bruise, and it is therefore probable that a fracture of one of these bones may often pass undetected.

As post-mortem evidence of simple fracture of any of the carpal bones is not common, the following recent case may be worth recording. A man, æt. 40, was admitted into the Middlesex

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* R. W. Smith, op. cit. p. 162.

Hospital, Jan. 3d, 1861, having received in a fall several severe injuries, from the effects of which he died. The right wrist-joint had evidently suffered, though there was no external wound or deformity. Acute inflammation, and ultimately suppuration within the joint, supervened. After death, it was found that a piece about one inch in length was split off from the posterior surface of the lower end of the radius, and a fissure extended almost, but not entirely, across the middle of the scaphoid bone.

The *treatment* consists in keeping the wrist at rest, lightly bound to a splint, and in the use of cold lotions, or other antiphlogistic measures, if the inflammatory symptoms are severe.

2. *Fracture of the metacarpal bones.* These bones are much more exposed to injury than the last-named. The usual cause of fracture in them is direct violence, but we not unfrequently find it occasioned by striking a blow with, or falling upon, the closed fist. It is met with far more frequently in men than in women, and chiefly between the ages of 15 and 45.

The statements that have hitherto been made as to the comparative liability of the different bones of the series to fracture are very unsatisfactory, owing to the insufficient number of observations upon which they are founded. Of the 113 cases which I have collected from the records of the Middlesex Hospital, in 71 the particular bone is mentioned. Of these, four are double fractures (two of the second and third, and two of the third and fourth), and in one the third, fourth, and fifth bones were broken; making in all 78 fractures. The number belonging to each bone is—

1st	27
2d	16
3d	9
4th	12
5th	14
Total . .	78

Probably an undue prominence is here given to the first, as, on account of its distinctive characters, it is more likely than any of the others to be particularised in describing the nature of the accident. Allowing for this probable source of error, we may still place it foremost in liability of fracture, as might be supposed from its position and extent of motion; the others seem to follow in order, as their situation exposes them to injury, the third or middle bone being last.

The fracture is usually in the middle or distal third of the bone; it is transverse or oblique, often attended with very little displacement, in which case the mobility of the fragments and the crepitus are the chief signs of the injury. Often, however, there is a displacement of the distal fragment, the head sinking down towards the palm, and the upper end forming with the extremity of the proximal fragment an angular projection on the dorsum of the hand. Sir A. Cooper* describes a fracture of the *head*, or more properly of the *neck*, of these bones; in young subjects this is probably a separation of the epiphysis.

The *treatment* of this injury, recommended by the eminent Surgeon just named, consists in causing the hand to grasp a large ball, and then binding a roller round the whole. I have generally modified this method by using a common rib-roller instead of the ball, and fixing the hand over it by means of adhesive plaster. Where there is much displacement, in order to obtain greater accuracy of adjustment, the plan recommended by Malgaigne is to be preferred. A thick compress is to be placed under the head of the bone so as to raise it, and another over the projection on the dorsal surface; these are kept in place by two broad splints placed across the hand, one above and one below, their ends being firmly drawn together by strips of plaster. The fingers should be left free, so as to avoid too great an amount of stiffness. If the metacarpal bone of the thumb is broken, it must be treated in the same manner as one of the phalanges, which it resembles so closely in its characters.

3. *Fractures of the phalanges.* From their very exposed situation, these small bones are often broken, usually with wound or severe bruising, amounting frequently to complete comminution of the whole member. Simple fracture of the phalanges is, however, by no means uncommon, and is generally caused by direct, but occasionally by indirect, force. The first phalanx, being largest and most fixed in position, seems to suffer most; but we have not yet sufficiently reliable data to determine even approximatively the relative frequency of injury to the different bones of this series. The fracture usually occurs about the middle of the bone; and although there is rarely much displacement, the diagnosis is generally established without difficulty from the crepitus and mobility of the fragments.

The *treatment* usually recommended is, to fasten a narrow straight wooden splint beneath the finger, with a small pad opposite the middle of the broken phalanx, to fill up the concavity which naturally exists between the joints. The splint may be more conveniently fixed to the dorsal surface, especially when it is one of the phalanges of the thumb that is broken. A more comfortable support is given by a splint of gutta-percha or pasteboard, moulded to the shape of the finger, which may then be allowed to be slightly flexed at each of the joints. It may be released from its confinement, and passive motion may be commenced, at about the end of the third week.

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* Op. cit. p. 506.

DISLOCATIONS OF THE BONES OF THE UPPER EXTREMITY.

Dislocations of the Clavicle.

The articulation between the sternum and clavicle may properly be regarded as the first point at which a luxation of any of the bones of the upper extremity can take place. As fracture of the clavicle is such a common accident, it has been remarked with surprise by authors, that, considering the extreme smallness and shallowness of the sternal articular surface, dislocation does not oftener occur at this point; and explanations are sought for in the strength of the ligaments, &c. The circumstance is more readily accounted for by the fact, that the clavicle is so confined by surrounding structures as very much to limit the amount of movement at the joint, and it is consequently impossible either that the articulating surfaces can undergo much change in their relation to each other, or that any of the ligaments can be put greatly on the stretch. *Ceteris paribus*, the greater the extent of motion in a bone, the greater the liability to dislocation. Again, the causes which produce dislocation of the clavicle are different from, and not so frequently in operation as, those which usually occasion a fracture.

The cartilage of the first rib prevents displacement of the head of the clavicle downwards, but it may occur in any other direction. Following the order of frequency in which they are met with, we may describe:

1. Dislocation forwards. 2. Dislocation backwards. 3. Dislocation upwards.

1. *Forwards.* This may be complete or incomplete: in the former case, the head of the bone, besides projecting forwards, is depressed below its natural level; in the latter, it is usually slightly raised. The ordinary cause of this dislocation is some violence which pushes the outer end of the clavicle backwards, as a fall or blow on

the front of the shoulder. In children, it has been produced by simply pulling the arm.* It has been observed at most ages, from birth† to eighty-six,‡ more frequently in males than females. The prominent head of the clavicle seen and felt in its abnormal situation, covered only by the integument, leaves no doubt as to the nature of the injury, except in partial dislocations, where there is much swelling, or in very fat subjects.

Treatment. The bone is usually reduced without difficulty by drawing the shoulder outwards and backwards, the Surgeon's knee being placed between the scapulæ of the patient; while at the same time, if necessary, an assistant presses the head of the bone back into its place. The great disposition that it has to slip out again has led to the invention of many methods intended to retain it in place; but even after the greatest care, more or less deformity often remains. Fortunately the utility of the limb is not materially impaired, even if the bone remains unreduced. The two objects to be aimed at are: (1) to keep the shoulder fixed, and thrown upwards, outwards, and backwards; and (2) to exert pressure upon the head of the clavicle.

A pad in the axilla, a figure-of-eight bandage to the shoulders, with a sling to support the elbow, or, in fact, any of the apparatus used in fractured clavicle, will fulfil the former indication; while for the latter a common hernia-truss may be applied, the pad being placed on the projecting bone, and the spring passing under the axilla of the sound side, as recommended by Nélaton. The pressure requires to be kept up from six weeks to two months, though at the end of the former period passive motion of the arm and shoulder should be commenced, in order to overcome the stiffness of the joints that so long a confinement must necessarily occasion. Velpeau, upon the supposition that the displacement is chiefly due to the action of muscles, proposes to relax these by carrying the elbow inwards and forwards to the lower part of the sternum, so that the hand may rest upon the opposite shoulder; the outer end of the clavicle will then be inclined upwards and forwards, and pressed inwards.§

2. *Backwards.* This form of dislocation has been produced by a violent fall, driving the shoulder inwards and forwards,‖ by the

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* Melier, *Archiv. Gén. de Médecine,* tom. xix. p. 53.

† Fergusson, *Practical Surgery,* 4th edit. 1857, p. 249.

‡ Brasdor, *Mém. de l'Acad. de Chirurg.* tom. v. p. 588.

§ *Journal Hebdom. de Méd.* May 30th, 1835.

‖ See a case, caused by a fall while wrestling, by Mr. W. Brown of Callington, *Med. Gaz.* Aug. 1st, 1845.

shoulders being pressed together between a carriage-wheel and a wall, or by a force applied directly, so as to push the inner end of the clavicle backwards, as a kick from a horse. The head of the bone usually lies behind the upper part of the sternum, rather below its normal level. In extreme cases, symptoms dependent upon pressure upon the trachea and œsophagus are produced, as in that related by Sir A. Cooper, in which Mr. Davie of Bungay had to saw off the sternal end of the bone to prevent death from this cause: this, however, was not an example of traumatic dislocation, but was produced gradually by a progressively increasing curvature of the spine.

A characteristic case occurred in the practice of my colleague, Mr. De Morgan, at the Middlesex Hospital, in 1852, which I shall relate briefly, as illustrating the usual symptoms and treatment of this accident.* A girl, ten years of age, was knocked down by a carriage, and appears to have been trodden on by one of the horses. On admission, she suffered much from dyspnœa, the head was inclined forwards, and could not be raised without extreme pain. There were marks of bruising over the right shoulder and clavicle. Where the head of the bone should be, there was a depression into which the finger might be thrust, and the articular surface of the sternum could be distinctly felt, while the head of the clavicle was evidently behind it. The distance from the middle line to the acromion was shortened by a quarter of an inch. "On placing the knee against her spine, and gently drawing the two shoulders backwards, the bone was easily restored to its proper place, causing obvious relief to the dyspnœa; but immediately on leaving hold of the shoulders, the bone fell back, and the dyspnœa returned. A splint was then placed across the shoulders, with a pad between it and the spine, the shoulders being drawn to the splint by a bandage; by these means the bone was kept firmly in its place, pillows being so arranged along the patient's back that the splint should not feel uncomfortable. On the apparatus being fixed, she could lean her head backwards, and stated that her pain was much relieved." The splint was kept on for a fortnight; the bone being then quite steady in its place, she was allowed to remain in bed without any bandage. The articulation became in four weeks quite as firm as that on the other side, and the arm could be moved without causing any pain.

South relates a case of compound dislocation of the sternal end of the clavicle backwards, caused by a blow with the sharp end of a pickaxe.[*]

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* Reported by Mr. S. W. Sibley, *Med. Times and Gazette*, 1852, vol. i. p. 415.

3. *Upwards.* This accident has only recently acquired an established place in surgical pathology. Malgaigne has collected five examples, and Dr. F. H. Hamilton has added another which happened in America. They seem all to have been occasioned by a violent force which carried the shoulder downwards and inwards. The symptoms are very marked, the head of the bone being felt above the upper border of the sternum, lying between the sterno-mastoid and the sterno-hyoid muscles. There is probably complete rupture of all the ligaments of the joint, as well as the costo-clavicular ligament.

Reduction is easily effected by drawing the shoulder outwards and upwards, while the dislocated head is pressed down; but to retain it in this position is difficult, if not impossible. Malgaigne found the functions of the clavicle perfectly restored six months after the accident, although the sternal end was nearly a quarter of an inch above, and as much to the inner side, of its normal situation. In the case mentioned by Dr. Hamilton, the displacement was still greater; but the patient stated "that he felt no inconvenience or abatement of strength in the arm, except when he attempted to lift weights above his head."[†]

Dislocations of the Scapula.

These injuries are usually described as "*dislocations of the acromial end of the clavicle*," but it seems preferable, for the sake of uniformity in our nomenclature, which has now discarded such terms as "dislocation of the radius and ulna upon the carpus," "dislocation of the tibia at the ankle," &c., to consider it as a dislocation of the acromion process of the scapula from the clavicle, the latter being the more fixed point and nearest to the trunk. This designation has already been adopted by Skey[‡] and Maclise.[§] Luxation at this joint is more frequent than at the sterno-clavicular articulation.

In the great majority of cases, the acromion is forced *beneath* the outer end of the clavicle; occasionally the reverse happens, viz. the acromion is situated *above* the clavicle; and a third form has lately been described, in which the displacement is carried so far that the coracoid process, as well as the acromion, are placed above the clavicle.

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[*] South's *Chelius*, vol. i. p. 778. See also, on this subject, Baraduc. *Mémoires sur les Luxations de la Clavicule*, Paris, 1842.

[†] Op. cit. p. 523.

[‡] *Operative Surgery*, 2d edit. 1858, p. 94.

[§] *On Dislocations and Fractures*, 1859.

The cause of this injury is nearly always direct violence applied to the scapula, as in a fall in which the back or outer part of the shoulder comes in contact with the ground or some hard body, or a blow or kick upon the same part. The symptoms of the first and most usual variety are tolerably well marked. There is pain in the articulation; the motions of the arm, especially upwards, are restrained; the shoulder is depressed, and approximated to the sternum; the arm apparently lengthened, and the projection formed by the outer end of the clavicle lying upon the acromion process, is very easily recognised beneath the skin. In partial dislocations the symptoms are similar, but much less marked.

Treatment. If the shoulder is drawn backwards, and the outer end of the clavicle pressed upon, the bones are usually restored to their natural relation. There is always great difficulty in retaining them in position, owing to the flatness and obliquity of the articulating surfaces, as well as the contraction of the clavicular portion of the trapezius muscle; but fortunately, although exact coaptation may not be obtained, the ends of the bones appear to adapt themselves to their new conditions, and the utility of the limb is but little impaired. The shoulder must be fixed, and, in order to keep the scapula raised, and the outer end of the clavicle depressed, a stout compress should be placed upon the latter point, and retained by a broad band passed over it, and under the elbow of the same side, and tightened and fixed by a buckle. If greater pressure is required, a Petit's tourniquet, as used by M. Laugier, may be applied in the same manner. For the exact details of this arrangement, the reader is referred to special treatises on the subject;* but much must be left to the ingenuity of the Surgeon in each individual case.

The second and third forms of this dislocation mentioned above are extremely rare. Only three unequivocal examples are recorded of the former, and there are some doubts as to the authenticity of the published cases of the latter.

Two instances have been reported of dislocation both at the sterno-clavicular and acromio-clavicular articulation in the same subject, or "*simultaneous dislocation of both ends of the clavicle;*" the first by Richerand, and the second by Morel-Lavellée.†

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* Especially Malgaigne, op. cit. tom. ii. p. 440.

† *Gazette des Hôpitaux*, 1859, no. 33.

Dislocations of the Humerus.

The humerus is dislocated nearly as frequently as are all the other bones of the body together. The statistics of Malgaigne, and several other authors, assign a still larger proportion; but this arises from the fact that many of the luxations of smaller bones, as phalanges, are evidently omitted from their tables.

The peculiar structure of the shoulder-joint, the shallowness of the articular surface of the scapula, the large size and globular form of the head of the humerus, the very extensive movements and long leverage afforded by the arm, and its frequent exposure to injury in protecting the more important central organs of the body, are all circumstances which contribute to the facility and frequency of dislocation. On the other hand, the free mobility of the scapula has, to a certain extent, a counterbalancing influence.

Dislocation of the humerus is an accident chiefly met with in middle and advanced life; it is extremely rare during childhood and youth. A case was recently (Aug. 5th, 1860) brought to the Middlesex Hospital of a dislocation forwards, in an infant fourteen days old. The arm had been violently pulled and twisted. Mr. F. H. Watts, the house-surgeon, made such a careful examination as to leave no doubt respecting the nature of the injury, and on extension being applied, it was reduced with a characteristic snap.

Common as these injuries are, their pathology is still imperfectly understood, and great discrepancies exist in the classification and descriptions given by various writers who have directed their attention to them. The modern French Surgeons particularly have arrived at very different conclusions to those generally adopted in this country, not only as to the usual situation of the head of the humerus, but in regard to several other important points, even in the most common forms of dislocation.

As want of precision in the terms used in describing the different varieties of luxation has hitherto been a principal source of obscurity, it will be necessary, before proceeding further, to adopt a definite and intelligible system of nomenclature. The obliquity of the glenoid fossa, and the variations in the position of the scapula, render such words as downwards, forwards, inwards, &c., very inefficient as distinctive designations of particular forms of dislocation. Names derived from the relation of the head of the bone in its new situation to important contiguous osseous structures are more concise, expressive, and definite. Adopting this method, all the possible dislocations of the humerus readily group themselves into the following five divisions:

1. SUBCORACOID. Forwards and slightly downwards. On to the neck of the scapula, in front of the glenoid fossa, and immediately below the coracoid process. *Common.*

2. SUBGLENOID. Downwards and forwards. Head of the humerus in front of the inferior costa of the scapula, below the glenoid fossa. *Rare.*

3. SUBCLAVICULAR. To the inner side of the coracoid process; under the clavicle. *Very rare.*

4. SUPRACORACOID. Upwards and forwards. On to the fractured coracoid process. *Only three cases reported.*

5. SUBSPINOUS. Backwards. On to the back of the neck of the scapula, beneath the spine or posterior edge of the acromion. *Very rare.*

These names are all recognised in the system of Malgaigne; some of them may be not altogether free from objection, but it seems better to retain them than to run the risk of adding to the confusion by introducing new ones. For the sake of greater simplicity, the number of this author's divisions is reduced; his incomplete and complete subcoracoid and intracoracoid being included under one head, for reasons which I shall give presently, and his two forms of dislocation backwards being also classed together. Undoubtedly varieties are frequently met with intermediate between several of these forms, especially the first and second, but it appears unnecessary to give them separate names.

I shall commence with the description of the most common form.

1. *Subcoracoid.* Under this term are included dislocations which Malgaigne considers as belonging to two distinct varieties, and which he respectively designates *subcoracoid* and *intracoracoid.* Although there are doubtless characters by which well-marked cases of either can be determined, the difference between them is slight, and being rather of degree than of form, I can see no practical advantage in retaining it in our classification. Perhaps, for the purposes of critical investigation, they might be regarded as subvarieties of one common form. The main distinction between them seems to be this,—in both cases the groove between the articular head of the humerus and the great tuberosity, rests on the same part of the anterior edge of the glenoid fossa. If the posterior scapular muscles are entire, being put on the stretch, they cause the head of the humerus to be rotated outwards, and the *subcoracoid* variety is produced; if the injury has been inflicted with greater violence, and these muscles are separated from their attachments,

or the greater tuberosity broken off, or if, perhaps from some other cause, their action is diminished, the humerus is allowed to turn more inwards, and the greater part of its head is placed internal to a line falling from the tip of the coracoid process, and the injury is called *intracoracoid.* The name "*subcoracoid*" seems preferable for all these cases, as it is extremely expressive of the position of the head of the bone; while "*intracoracoid*" would have been more correctly applied to that form of dislocation in which it is truly on the inner side of the coracoid process, the one commonly called "*subclavicular.*"

Although quite unrecognised in the earlier, and only doubtfully admitted into many recent systematic works in this country, numerous cases of subcoracoid dislocation, in which the anatomical characters are accurately described, are to be found in the pages of our surgical treatises and periodicals. One of the earliest of these is the well-known case (now preserved in Univ. Coll. Museum) recorded by Thompson nearly a century ago.* A reference to the figures in the quarto edition of Sir A. Cooper's work will show that at least one of the specimens from which he described the anatomical characters of dislocation *downwards* really belonged to this form; and that the description of the position of the head of the bone in the text must have been influenced by the previous opinions of the writer.† The same may also be said of the case cited by this distinguished Surgeon, as an evidence of "partial dislocation." Many of the cases that have been published of dislocation forwards and inwards, or subclavicular, are nothing more than specimens of this variety. Of forty-one specimens of dislocation at the shoulder-joint, preserved in the different anatomical museums in London, as many as thirty-one undoubtedly belong to this form;‡ and of fifty recent cases which have come under the observation of myself, or gentlemen in whom I can place perfect confidence, and of which I have full particulars, in forty-four the head of the humerus was placed so closely beneath the coracoid process as to justify the appellation of "subcoracoid." In the face of these facts, it is difficult to understand how the wide-spread error of regarding the subglenoid as the typical form of dislocation at the shoulder-joint, should have been so long maintained. A simple process of reasoning upon the anatomical structure of the part would suffice to show that, whenever the humerus is thrown from its socket, it will almost of necessity be drawn upwards until it is arrested either by the coracoid process in front, or the spine or acromion behind. Even in the dead subject, when dislocation is artificially produced by forcibly elevating the arm, while the scapula is fixed, the humerus is almost always drawn up close against the under surface of the coracoid process; *à fortiori*, in the living, must the action of the deltoid, coraco-brachialis, and biceps cause it to assume this position. In fractures about the neck of the humerus, the action of these muscles in raising the lower fragment has long been recognised. The truth is, that nearly all the cases of "dislocation into the axilla," or "downwards," described as so common by Sir A. Cooper, and all subsequent British authors, have really been examples of this variety, to which the anatomical characters of the more rare "subglenoid" dislocation have been erroneously applied.

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* *Med. Obs. and Inquiries*, 1762, vol. ii. p. 340. † Fifth edit. 1826.

‡ See a paper by the author, *Trans. Path. Soc.* vol. xii.

Subcoracoid dislocation may be produced either by a direct force applied to the upper part of the humerus, driving it forwards and inwards, as a blow or fall upon the shoulder, or secondly, by forcible elevation of the distal end of the humerus, such as may be caused by a fall upon the elbow or hand, when extended from the body. In the forty-four cases above mentioned, the causes were as follows:—falls or blows upon the shoulder, in eighteen; upon the elbow, in five; upon the hand, in ten; while in eleven cases the cause was of doubtful or exceptional nature, including two from muscular action. Of these, one took place in attempting to strike a violent blow at a man, who eluded the stroke; the other in putting on a coat. In the last case, however, the humerus had been frequently dislocated before.

Symptoms. The patient complains of pain about the joint, especially on the inner part, along the course of the great nerves of the brachial plexus, sometimes extending down the arm as far as the fingers, and accompanied by a sensation of numbness. He is quite unable to move the arm at the shoulder; the elbow projects from the side, and cannot be made to touch the chest, at least without causing pain; it is sometimes carried rather behind, sometimes in front of the body, and is frequently rotated rather inwards, but occasionally outwards. The movements of the fore-arm and hand are not impaired. On examining the shoulder more closely, and comparing it with the uninjured side, a striking change is apparent in its form, especially distinct, of course, if the patient is thin and no great inflammatory swelling has taken place. The natural roundness is lost, the acromion appears remarkably prominent, and beneath it there is a depression into which the fingers can be pressed; and in some subjects even the form of the glenoid fossa of the scapula can be distinguished through the fibres of the deltoid. The axis of the humerus is evidently altered; instead of being directed to the glenoid fossa, it points to a spot internal, anterior to, and below it. The limb usually appears lengthened; but on carefully measuring from the acromion process to the external condyle, and comparing it with the opposite side, we find it frequently equal, or somewhat shorter. Of forty-four cases of subcoracoid dislocation, the arm was elongated in nineteen, unaltered in eight, and shortened in seventeen; the greatest elongation being one inch, the greatest amount of shortening $\frac{7}{3}$ inch. Measurement of the vertical circumference of the shoulder, by carrying a tape over the acromion and under the axilla, always gives an increase of from one to two inches over the uninjured side; an important diagnostic sign, common to all forms of dislocations of the humerus, as pointed out by Mr. Callaway.* The anterior fold of the axilla is deeper and fuller than natural, the pectoral muscle being raised by a rounded swelling, which partly effaces the subclavicular fossa. On placing the fingers in the axilla, the upper and anterior part of this space is found to be occupied by the head of the humerus, here covered only by the integument, and moving readily with every movement communicated to the elbow. Or it may be that the upper part of the shaft only is felt at first in the axilla; but on raising the arm from the body, the globular form of the head can generally be detected.

Abundant opportunity is afforded in our museums of studying the effects of this accident, both in the recent state and when left long unreduced; and its usual anatomical characters can be ascertained with great precision when it is artificially produced in the dead subject.

The head of the humerus lies on the anterior surface of the neck of the scapula, immediately below the coracoid process, in front of, internal to, and rather lower than, its normal situation. That part of the anatomical neck which separates the articular surface from the great tuberosity rests upon the anterior edge of the glenoid fossa. The subscapular muscle is raised from the neck of the scapula, and stretched over the front of, or above the head of, the humerus. The muscles from the back of the scapula (supraspinatus, infraspinatus, and teres minor) are drawn tightly across the glenoid fossa, or one or more of them may be ruptured, or detached from the bone. A portion, or the whole, of the greater tuberosity is frequently separated, when it may be drawn into the glenoid fossa by the action of the muscles inserted into it, or may be retained in connexion with the humerus by the periosteum, or the capsular ligament. The long tendon of the biceps is rarely, if ever, injured.* The muscles that descend from the coracoid process to the humerus are stretched by the projection of the head of the bone forwards, and the great vessels and nerves are displaced inwards. Occasionally the circumflex nerve is pressed upon to such an extent as to cause paralysis of the deltoid muscle.† Lastly, the capsular ligament is lacerated more or less extensively, anteriorly and inferiorly, the upper end of the humerus having escaped through the aperture.

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* *Dissertation upon Dislocations and Fractures of the Clavicle and Shoulder-Joint*, 1849.

When left long unreduced, important changes take place in the affected structures. Those that are common to all dislocations, as the formation of a new capsule and fibrous socket, need not be detailed here, but the peculiar alterations in the contiguous extremities of the two bones belong to the special part of the subject.

In process of time a new shallow socket is formed upon the anterior surface of the neck of the scapula, partly by absorption of old bone, and partly by deposit of new, around its edge. The exact position of this socket varies according to the degree of displacement of the humerus: in the first variety (*subcoracoid* of Malgaigne), the new cavity is formed more or less at the expense of the anterior portion of the glenoid fossa, which is gradually worn away, so that in some cases the original socket is finally almost entirely lost. A corresponding change takes place in the head of the humerus: where it rests upon the edge of the glenoid fossa, absorption occurs, so that a groove is excavated, usually between the articular head and the great tuberosity. With continued friction, this increases in size simultaneously with the changes in the scapula; the two accommodate themselves to each other, and ultimately the head of the latter bone presents a double articular surface, separated by a vertical ridge; the posterior portion being part of the old glenoid cavity, the anterior the newly-formed socket. These respectively articulate with the two sides of a wide groove placed vertically on the head of the humerus, and thus a rude kind of joint, which allows of a certain amount of motion, is formed. In consequence of the absorption that has taken place in both bones, the head of the humerus has by this time made considerable progress towards regaining the position it occupied before the injury, and therefore the external signs of dislocation become to a certain extent removed. The under surface of the coracoid process, especially near its tip, is almost always found smooth and eburnated, having entered into the formation of the new articulation.* If the head of the humerus is placed further under the coracoid process (*intracoracoid* of Malgaigne), the new socket upon the neck of the scapula is formed quite outside the margin of the glenoid fossa, upon which it does not encroach. It is then a simple cup-shaped depression, and the head of the humerus undergoes none of the changes above described, but is generally worn away on the side of the greater tuberosity by the friction against the anterior edge of the glenoid fossa, and hence assumes a somewhat oval shape. In these cases the coracoid process is not usually a part of the new articulation. Between the two extremes, all intermediate varieties are found; the position of the new socket, quite free from, or more or less encroaching upon, the glenoid fossa, the head of the humerus unaltered, flattened on its outer side, or grooved, being circumstances which all depend upon the exact situation in which the bone has found its new lodgment. As in unreduced dislocations of long standing elsewhere, the surfaces of the bones which are in contact are generally divested of cartilage, and in places hard and polished.

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* As Dr. Hamilton has recently asserted that, "contrary to what has been affirmed by Sir Astley Cooper, the tendon of the long head of the biceps is often broken asunder, or detached completely from its insertion" (op. cit. p. 535), I may mention that the statement in the text is founded on examination of numerous specimens and reports of dissections.

† See a preparation in the museum of St. Bartholomew's Hospital. A 42.

As the history of the case is unknown in most of the museum specimens, it is difficult to determine the length of time required to effect these changes; probably it varies much under different circumstances. In a specimen in St. Bartholomew's Hospital museum,† in which the accident is said to have occurred three months before death, absorption of the anterior edge of the glenoid fossa has already commenced, and some bone is deposited in the margin of the new socket.

2. *Subglenoid.* As every intermediate condition may be met

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* Specimens which have presented these characters have generally been cited as examples of "partial dislocation."

† C 103.

with between this and the last, it may be regarded as a variety of that common injury, in which the head of the humerus, instead of being drawn up against the coracoid process by the action of the muscles passing from the shoulder to the arm, has remained at some distance below this point.

According to Malle, the principal circumstance which prevents the bone ascending, seems to be that the anterior portion of the capsular ligament remains entire, rupture of the lower part only having taken place.*

In the most characteristic cases, the head of the humerus is thrown below the glenoid fossa, and rather forwards and inwards, resting upon the inner border of the inferior costa of the scapula, and may be felt very prominently in the axilla. The symptoms are much the same as in subcoracoid dislocation, but rather more marked. The depression beneath the acromion is greater; the arm is separated further from the side, and is generally lengthened, but occasionally is unaltered in this respect, or it may be even shortened. This variation in length may be accounted for, partly by the uncertain position of the head of the humerus, which may be either close upon the edge of the glenoid cavity, or further back in the subscapular fossa, and partly by the diminution of the distance between the acromion and the external condyle, dependent upon the projection of the elbow from the side.† On the whole, the length of the arm is little to be depended on as a diagnostic mark of dislocation. The main distinction between this and the last, is the interval, of from one to two fingers' breadth, felt between the coracoid process and the head of the humerus.

The most common cause of subglenoid dislocation is a fall upon the hand or elbow; it rarely proceeds from a direct blow upon the shoulder.

In the only two specimens of unreduced dislocations of this kind that I have been able to find in the anatomical museums of London, a new osseous socket has formed for the head of the humerus on the upper part of the anterior border of the inferior costa of the scapula, encroaching considerably upon the lower and anterior part of the glenoid fossa. One of these‡ has been figured by Sir A. Cooper, and its subsequent reproduction by other authors has contributed much to confirm the error of regarding this as the usual form of dislocation at the shoulder. From examination of specimens in museums, and from numerous recent cases, I should conclude that not more than one in ten, of all dislocations of the humerus can properly be called subglenoid.

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* "Mémoire sur les Luxations scapulo-humerales," *Mém. de l'Acad. de Méd.* tom. viii. p. 595. See also Goyrand, "Nouvelles Etudes sur la luxation n bas ou sous-glénoidienne," *Mém. de la Soc. de Chirurgie*, tom. i. p. 21.

† Well illustrated by a diagram in Callaway's *Essay on the Shoulder-Joint*, p. 109.

‡ Now in the museum of St. Thomas's Hospital, B 11. The other is in

3. *Subclavicular.* "The head of the os humeri placed below the middle of the clavicle, and on the sternal side of the coracoid process." As the last may be regarded as a variety of the ordinary form of dislocation in which the head of the humerus is placed unusually low, so may this be considered as one, in which it has passed further than common in an inward and upward direction. The cases in which the position of the bone exactly corresponds to the above definition of Sir A. Cooper must be very rare indeed, although there are a sufficient number on record to prove the possibility of its occurrence. In one example described by Malgaigne, the head of the humerus was thrust between the deltoid and the pectoralis major, and was only covered in the interval by the integuments.

We know little of the anatomical characters of this injury, and there is no preparation in any of the London museums which exhibits them. In one specimen in St. Bartholomew's Hospital museum,* the head of the humerus is said to have been "found resting on the subscapular fossa, and immediately below the clavicle;" but it has unfortunately been removed from this situation in putting up the preparation. In two cases of unreduced dislocation in another museum, in which the head of the bone is described in the catalogue as being "under the clavicle," the new socket is distinctly seen to be immediately below the coracoid process. This, I suspect, has been really the case in most of the so-called "subclavicular" dislocations which have been put on record. In consequence of the subcoracoid not having been recognised as a common variety, any dislocation that was not subglenoid, was necessarily supposed to be subclavicular.

The characteristic symptoms, according to Malgaigne, are as follows: the arm is pressed against the chest, it appears in some cases to be lengthened, in others shortened; the elbow is but slightly removed from the side, and points either directly outwards or somewhat backwards. The head of the humerus is felt on the

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the museum of the Royal College of Surgeons, no. 3275. There is a specimen in King's College museum (no. 1342) which is intermediate between subcoracoid and subglenoid.

* Series iii. no. 55.

inner side of the coracoid process, making usually a very apparent projection forwards. Sometimes it is by no means so conspicuous, but lies deeply in the subclavicular fossa. It approaches the clavicle in some cases so nearly as to touch it. In the axilla the shaft is felt, but not the head of the bone, even when the arm is raised to a right angle with the body. The causes are either a violent blow or fall directly on the outside of the shoulder, or a fall upon the hand or elbow, pushing the humerus directly upwards and inwards.

4. *Supracoracoid.* Malgaigne founded this variety upon a single case, in which the head of the humerus appeared to be dislocated upwards and forwards, and rested upon the coraco-acromial ligament, touching externally the inner border of the acromion, internally the coracoid process, which it covered, and projecting under and raising the deltoid.* More recently, Mr. Holmes has published an account of the dissection of a case where the coracoid process being fractured, the head of the humerus rested on its stump, and on the clavicle, fairly out of, above, and a little anterior to, the glenoid fossa, and, having passed through the fibres of the deltoid muscle, was only covered by the integument. The long tendon of the biceps was displaced to the outer side of the head of the bone. The preparation is now in the museum of St. George's Hospital. In the same paper the symptoms of an apparently similar case, observed by Mr. Prescott Hewett, are described.†

5. *Subspinous.* This is also a rare form of injury, but one of which the characters are so well marked, that it is not liable to be confounded with any of the others. There are four good specimens, illustrating its effects when left unreduced, in the anatomical museums of London. Out of 159 cases of scapulo-humeral luxation recorded at the Middlesex Hospital, three are assigned to this variety.

Malgaigne describes two forms of dislocation backwards, "subacromial" and "subspinous." As the former is only a less complete variety of the latter, it seems unnecessary to retain the distinction. The subacromial is undoubtedly the most common; but the name is objectionable, as it does not express any change from the normal situation of the head of the humerus.

The displaced head of the bone may rest either on the posterior edge of the glenoid fossa, on the back of the neck of the scapula, beneath the posterior angle of the acromion, or, more rarely, on the dorsum of the scapula below the spine. On dissection, the tendon of the subscapularis is generally found to be detached from the lesser tuberosity.

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* Op. cit. tom. ii. p. 530.

† *Medico-Chirurg. Trans.* vol. xli. p. 447.

The symptoms vary according to the amount of displacement of the head of the bone, being proportionately more marked as this is further removed from the glenoid cavity. There is always the flattening of the shoulder and prominence of the acromion, common to all luxations of the humerus. The head of the bone, covered with muscles, forms a marked protuberance on the back of the scapula, immediately under the posterior angle of the acromion; in front, between it and the coracoid process, is a considerable depression. The length of the arm is unaltered, or but slightly increased; it is generally applied closely to the side, and rotated inwards, with the elbow usually advanced. The most frequent causes of dislocation backwards, are falls either upon the shoulder, or upon the elbow when advanced. Violent twisting of the arm inwards has produced it, and so has, not unfrequently, convulsive muscular action in a fit of epilepsy.

Partial dislocations. Sir A. Cooper and most of his contemporaries believed in the existence of these injuries, but many recent surgical authors doubt even the possibility of the head of the humerus being retained in the position indicated by the term "partial dislocation," unless under very exceptional circumstances. Malgaigne, rejecting the greater number of cases previously brought forward, as being examples, either of complete luxation, or of pathological changes in the articulation, has described several, which appear to him conclusive instances of "incomplete subcoracoid dislocation." But these cases are not, in my opinion, either in their symptoms or post-mortem appearances, sufficiently distinct from the ordinary form of the injury to warrant our placing them in a separate division. I am therefore disposed to agree with Dr. R. Adams in denying "that the case of partial luxation of the head of the humerus, as the result of accident, has ever been satisfactorily proved, either in the living or the dead subject."*

Treatment. The great majority of cases of dislocation of the humerus, when recent, are reduced by the skilful Surgeon without difficulty. It is only where the injury is of such long standing that the parts have become rigid, and are beginning to adapt themselves to their new state, or in some of the more unusual positions of the bone, that any mechanical aid need be brought into requisition. The method of treatment which is best adapted for the ordinary forms of scapulo-humeral dislocation will be considered first, and the special modifications required for the rarer varieties will be mentioned afterwards.

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* Art. "Abnormal Conditions of the Shoulder-Joint," *Cyclop. Anat. and Physiology*, vol. iv. p. 606.

The use of chloroform has now superseded all the agents formerly employed to produce a lax condition of those muscles which, by their spasmodic contraction, often present so great an obstacle to the reduction. Whether it is administered or not in any individual case, will depend upon the condition of the patient, and the estimate placed by the Surgeon upon the value and the danger of this powerful agent. In recent dislocations, when the patient is of average size and muscularity, it is not usually required, at all events not until after an attempt at reduction by the usual methods has failed, and some more severe means have to be put into operation. In persons of great muscular power, and especially if two or three days have elapsed since the injury, its administration will be advisable. After a longer period, no attempt at reduction should be made without it, not only on account of the saving of pain, but because it renders the chances of success far more favourable.

In very relaxed subjects, especially if it is not the first time of the occurrence of the injury, it sometimes happens that a slight movement of the limb on the part of the Surgeon will effect the reduction. Either while lifting the arm from the side, or in pressing upon the head of the bone with the fingers in the process of examination, it is felt to go back into its place with a slight snap. But in most cases it is held in its new position with such an amount of firmness as to require that further measures should be taken. Nearly all Surgeons who have approached the subject scientifically have agreed, both from reasoning and experiment, that the direction which most favours reduction of the humerus, both by obviating mechanical obstacles and by relaxing the tension of the numerous muscles that pass to it from the scapula, is one in which the axis of the bone shall be a line exactly perpendicular to the surface of the glenoid fossa, which line, if prolonged backwards, is nearly coincident with the lower border of the spine of the scapula. In all the most successful methods of reduction the traction is in reality exercised more or less in this line, although, if the scapula is regarded as a fixed instead of a movable point, it may seem otherwise. But, in fact, so much can this bone turn upon its axis, that, whether in the method of pulling the humerus upwards, advocated by White and La Mothe, horizontally outwards recommended by Malgaigne, or downwards with the heel in the axilla, so generally adopted by Sir A. Cooper and most Surgeons in this country, although the line of traction appears so widely different as regards the body of the patient, yet the two points with which we have specially to deal, viz. the glenoid fossa and head of the humerus, are not far different in their relation to each other. The importance of the mobility of the scapula in facilitating the reduction of dislocations, hitherto much overlooked, has been particularly pointed out by Mr. Skey.*

When we have a recent case to deal with, in which we do not anticipate any particular difficulty, we may commence with the following, as the simplest method of reduction. The patient, seated on a chair, may be led to believe that the examination is still going on, so that no extraordinary effort of resistance on his part takes place; for if he is prepared for what he believes must be a serious operation, the muscles are often involuntarily rendered tense. The Surgeon, standing behind or before the patient, as is most convenient, places his left hand upon the shoulder to steady it, and with the other, grasping the arm a little above the elbow (which should be flexed in order to relax the biceps), raises it rather above the horizontal line, giving it a slight rotatory motion inwards, combined with moderate extension; at the same time, with the fingers or thumb of the hand which is placed upon the shoulder, the head of the bone may be pressed backwards and upwards into the glenoid cavity. In this way, dislocations may often be reduced without any assistance. Without altering the position of the patient, the Surgeon may gain more power over the humerus by placing his foot upon the side of the chair, and pressing his knee into the axilla, by which means he will get some counter-pressure against the wall of the chest, and firmer leverage, to raise the upper end of the humerus into its place.

In the event of failure by these simple methods, another plan, in which, although the direction of the humerus is not quite so advantageous, a very effectual means of counter-extension is obtained, and which also has the merit of requiring no assistance, may be tried. The patient is placed upon his back upon a couch, and the Surgeon, seated by the affected side, places his heel (the boot being removed) well up into the axilla, pressing upon the lower border of the scapula; grasping with both hands the lower part of the fore-arm, and leaning himself backwards, he draws the limb steadily downwards; the heel being at the same time made to press the head of the bone outwards. Directly it is felt to slip back into the socket, the extension should cease, and the fore-arm be brought across the chest.

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* *Operative Surgery*, 2d edit. 1858, p. 105.

If the humerus still resists, the following plan, which I have never known to fail in a recent dislocation, may be tried. The patient is seated on a high chair, which is placed about two feet from the post of an open doorway. The Surgeon, leaning his back against the door-post, places one foot upon the side of the chair, and, with his knee pressed into the axilla and both hands upon the shoulder, steadies the patient's body. A jack-towel is then fixed by a clove-hitch knot to the patient's arm, just above the elbow; and by its means two or more assistants, placed on the other side of the doorway, make steady extension horizontally outwards. Counter-extension from the opposite wrist has recently been advocated in America.*

It is scarcely necessary to say, that in all cases the traction must be gradual, steady, and continued, never violent or sudden; and as these conditions can be obtained more surely by means of the pulleys than by the exertions of assistants, in old-standing cases, where not only the resistance of muscular spasm has to be overcome, but fibrous adhesions have also to be broken down, it will be necessary to resort to these aids. The extending power is fastened either to the lower end of the humerus or to the fore-arm just above the wrist, and the shoulder is fixed by towels or straps passed under the axilla, and made fast to a staple in the wall. As the usual arrangements for counter-extension have the great disadvantage of compressing the walls of the axilla, and so making tension upon the pectoralis major and latissimus dorsi muscles, which ought to be relaxed, Mr. Skey employs a well-padded iron knob, from which two strong branches of the same metal extend laterally, each about four inches in length, ending in a bulb or ring, the office of which is to keep the margins of the axilla as free from pressure as possible, and to which the cords from the staples are attached; the iron knob is passed high into the axilla, and acts as the heel in the ordinary operation.†

In a case of twenty-five days' standing, which resisted all attempts at reduction by extension, Mr. Cock, at Guy's Hospital, adopted the following plan: "an air-pad made of vulcanised india-rubber was placed in the axilla, and the arm firmly bandaged to the side; the air-pad thus being made to exert a powerful outward pressure upon the head of the bone. Upon removing the bandage upon the third day, the head of the bone was found to have returned to its natural position."*

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* See F. H. Hamilton, op. cit. p. 546.

† See figure in Skey's *Operative Surgery*, 2d edit. p. 106.

Dislocations downwards or backwards may be reduced upon much the same principles as those under the coracoid process; in the latter case the traction should be made in a somewhat forward direction. The true subclavicular dislocation is the most difficult to manage, and has sometimes resisted every attempt at reduction, even in the hands of the most experienced Surgeons. To disengage the head of the humerus from the coracoid process, it will have to be drawn downwards and forwards.

When reduction has been accomplished, the joint should be kept at rest for two or three weeks, the arm being placed in a sling with the elbow lightly bound to the side, and all violent exercise prohibited for several months, as a comparatively slight cause may produce a second dislocation. Hamilton, who has given us many valuable observations upon the results of dislocations, makes the remark, that "the head of the humerus sometimes remains for a long time after the reduction has been effected slightly advanced in its socket, so as to lead to a suspicion that it is not properly reduced;" and states that the probable explanation of this circumstance is, that "the long head of the biceps has been broken or displaced."† I think that it should be attributed rather to injury of the posterior scapular muscles, which, as before mentioned, suffer more frequently than the tendon of the biceps.

In cases that have been neglected it often becomes a question, whether we are justified in attempting a reduction, or whether the head of the bone should be left with the new connexions it has formed, undisturbed. On this point the Surgeon must exercise his judgment in each particular case; but, as a general rule, the limit laid down by Sir A. Cooper, of twelve weeks, may be taken as a guide. Many Surgeons have, indeed, ventured much further, and cases are reported of successful reductions after twelve, and even eighteen months; but it must not be forgotten that we know less than we should do of the serious accidents which have often attended such attempts, one of the most frequent of which is laceration of the axillary artery. Already a considerable list of fatal cases from this cause might be collected.‡

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* Bryant, *Diseases and Injuries of Joints*, 1859, p. 227.

† Op. cit. p. 569.

‡ See Hamilton, op. cit. p. 554.

Compound dislocation at the shoulder-joint is extremely rare, although cases have been met with in which the head of the humerus has been driven through the skin. It still remains to be determined by experience, whether under such circumstances reduction, or resection of the head of the bone, is the safer method of treatment. The latter practice is most likely to be followed by success, if we may draw inferences from the results that have been obtained by its adoption in similar injuries to other articulations.

When fracture of the shaft accompanies dislocation of the head of the humerus, the bone should be firmly put up in straight splints, and, chloroform being administered, reduction should be attempted by the usual methods. Dislocations combined with fractures of the neck are often impossible to reduce, and, as several preparations in our museums show, they then terminate either in union in the new position, or in the formation of a false joint between the fractured ends, in either case accompanied by shortening of the limb. Since the introduction of chloroform, however, more favourable results have been obtained in these cases; for when the muscles are thoroughly relaxed, and gentle extension is made on the shaft, the head of the bone can often be manipulated back into its socket. Then it must be fixed by a pad in the axilla and a gutta-percha splint over the shoulder, before the recovery of the patient from the anæsthetic allows the muscles to resume their spasmodic contractions.

Among the rarer complications of dislocated humerus may be mentioned rupture of the axillary artery, of which a case is related by Dr. R. Adams. It was recognised by the diffused aneurismal swelling in the axilla, and absence of pulse at the wrist. After the dislocation was reduced, the subclavian artery was tied, and the patient recovered.*

Occasionally both humeri are dislocated at the same time. A man was brought recently to the Middlesex Hospital, to whom this had occurred in falling into a cellar, with both arms stretched out before him.

Dislocations of the Ulna and Radius at the Elbow-joint.

Though dislocation of the humerus rarely occurs before the age of twenty, the bones of the fore-arm are especially liable to this accident in childhood and youth. More than one-half of the cases of dislocation at the elbow, in the statistical table at p. 525, occurred in boys between the age of five and fifteen. Of thirty-three cases observed by Dr. F. H. Hamilton, nineteen were in children under fourteen years of age.

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* *Cyclop. Anat. and Phys.*, art. "Shoulder, Abnormal Conditions of," p. 616.

Malgaigne concludes, from experiments upon the dead subject, and from careful examination and interrogation of patients who have met with this accident, that the most frequent cause of nearly every form of luxation at the elbow-joint, is a twist given to the ulna, which brings the coronoid process successively inwards, downwards and backwards, and which may be produced by a fall upon either the internal border of the fore-arm, or the inner side of the olecranon. Other authors state that this injury is more frequently occasioned by a fall in which the palm of the hand comes into violent contact with the ground, so that the fore-arm is driven directly back under the lower end of the humerus.

The bones may be displaced backwards, forwards, or to either side; besides these, there may be intermediate forms, as backwards and outwards, backwards and inwards. Each form may be incomplete, or complete; and as exceedingly rare varieties may be mentioned, dislocation of the ulna alone backwards, the radius remaining in its normal situation, and a dislocation of both ulna and radius, in which the former is displaced backwards and the latter forwards, with reference to the lower end of the humerus. There may also be the complication of fracture of the olecranon or coronoid process of the ulna, of either of the condyles of the humerus, or of the head of the radius, or the dislocation may be compound. Much swelling of the arm often follows these accidents, frequently masking their special characters, and rendering it difficult to establish an accurate diagnosis.

The only one of the above-named varieties which is at all common, is *dislocation of both bones of the fore-arm backwards.* When this is complete, the coronoid process (if not fractured) is lodged in the olecranon fossa of the humerus. According to Malgaigne, this condition is not so common as the incomplete form, in which the process rests upon the trochlea of the humerus. The radius almost always maintains its relative position to the ulna, being held by the orbicular ligament. The anterior and two lateral ligaments of the elbow-joint are generally torn.

The following symptoms accompany dislocation backwards, when in its most complete and characteristic form. The whole arm appears shortened. The fore-arm is slightly flexed and pronated; it can be moved from side to side upon the humerus if that bone be fixed. The elbow exhibits a marked deformity, being increased in its antero-posterior diameter. The olecranon is carried backwards and upwards, so that its point is above the condyles of the humerus; the tendon of the triceps attached to it is rendered very prominent. On the external side the head of the radius, carried entirely behind the humerus, can be recognised rolling upon the ulna when the hand is rotated. Anteriorly the lower end of the humerus forms a prominence, over which the tendons of the biceps and of the brachialis anticus muscle are stretched.

The various *lateral* displacements may readily be recognised by the deformity of the elbow occasioned by the new relations of the bones to each other. Dislocation outwards is much more frequent than in the opposite direction.

The luxation *forwards* is extremely rare, and yet it has been met with, both in the incomplete and complete form; in the former the summit of the olecranon rests against the inferior part of the trochlea of the humerus, and the radius is below and somewhat separated from the external condyle; the prominence of the olecranon posteriorly has disappeared, and on each side the condyles of the humerus are unusually prominent, with a depression below them; the arm is elongated. In the complete dislocation all the above characters are present in a more marked degree.

Treatment. The reduction of dislocations at the elbow-joint is not generally attended with much difficulty, and, with slight modifications, which will readily suggest themselves to the Surgeon upon consideration of the anatomy of the joint, is conducted on the same principle for all the varieties. The method recommended by Sir A. Cooper, and which is generally adopted, is as follows: the patient sits upon a chair, and the Surgeon, resting his foot upon the edge of the seat, places his knee upon the inner side of the elbow-joint, while he grasps the wrist with his hands; he then bends the elbow slowly, but forcibly, at the same time pressing with his knee upon the upper part of the ulna and radius, so as to disengage their articular surfaces from the lower end of the humerus. This method has the advantage of not requiring an assistant; but where help can be procured, extension of the fore-arm directly downwards, as advocated by Mr. Skey, is to be preferred: one person holds the upper arm, while one or more pull steadily at the wrist, and as soon as the coronoid process is brought below the level of the trochlea of the humerus, the action of the muscles bearing upon it, causes it to slip up into its natural place. The after-treatment consists in keeping the arm in the bent position in a sling for two or three weeks, adopting the usual methods for preventing too great inflammatory action, and cautiously commencing passive motion in ten or fourteen days. If as much as a month or six weeks have been allowed to elapse before reduction, great difficulties will be met with. There are, however, cases on record in which it has been successfully performed after five or six months. On the other hand, frequent failures, severe accidents, and even death, have been the consequences of such attempts.

In *compound dislocations* at the elbow-joint, if there be extensive laceration of the soft parts, with lesion of the great vessels and nerves of the limb, amputation may be required. In most cases, however, it will be only necessary to enlarge the wound, to remove the articular ends of the bones, and trust to the formation of a fibrous joint. Although these are the rules for the treatment of such injuries generally laid down in modern surgical works, there are certainly cases in which neither of the above proceedings are necessary. If the patient is of healthy constitution, and the external wound not large, nor accompanied by any great amount of contusion, reduction may be effected, the wound closed, and cold water or other antiphlogistics assiduously applied. In a case thus treated lately under my care, the patient (a labouring man, æt. 34) had fallen from a height of twenty feet upon a boarded floor. The bones of the left fore-arm were dislocated backwards and outwards, and there was a wound between the olecranon and the internal condyle sufficiently large to admit the finger into the joint, and through which a considerable portion of the cartilaginous surface of the trochlea of the humerus could be distinctly seen. But little inflammatory action took place; the wound healed rapidly; in a fortnight passive motion of the elbow was commenced, and in less than two months the use of the joint was perfectly restored.* For further observations upon the treatment of injuries of the elbow-joint complicated with wound, see p. 522.

Dislocations of the Head of the Radius.

The head of the radius is sometimes displaced from its connexions with the lesser sigmoid notch of the ulna, and the capitellum of the humerus. This injury usually occurs at an early age, and has been observed even in very young infants. The causes are, either a fall in which the palm of the hand, coming in violent contact with the ground, communicates the shock to the radius in such a manner as to cause the upper end to start from its attachments, or a fall upon the elbow itself, or a violent pull on the radius, as when young children are suddenly lifted off the ground by the hand.

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* See *Lancet*, 1860, vol. ii. p. 300.

The head of the radius may be displaced in either of three directions—forwards, backwards, and outwards; the first by far the most common, the last extremely rare. In any of these the displacement may be complete or incomplete; in the former condition, the orbicular ligament appears always to be ruptured; in the latter, it may be only stretched.

In the dislocation *forwards*, the head of the radius lies on the front of the external condyle of the humerus. The following are the most characteristic symptoms; the fore-arm is fixed in a slightly flexed state, either prone or midway between supination and pronation. Bending of the elbow is prevented by the head of the radius coming in contact with the front of the humerus, and complete extension causes pain. The head can be defined in its new position, and when the hand is rotated, it will be felt to move. The whole fore-arm has a peculiar and characteristic twist, occasioned by the altered situation of the upper end of the radius.

Dislocations backwards, or outwards, are distinguished by the head of the bone being felt subcutaneously in these positions. They are often accompanied by fracture of the external condyle.

Treatment. Whatever be the nature of the displacement, direct extension from the hand will be found the most efficient means of reduction, combined, if necessary, with pressure by the fingers upon the projecting head of the bone in the required direction. The arm should then be put up in a gutta-percha splint. If, in consequence of the rupture of the annular ligament, there is difficulty in maintaining the head of the radius in its place, a firm pad must be fixed upon it. After dislocation forwards, caution must be used in straightening the arm for the first time; for if the ligaments are not perfectly united, the action of the biceps upon the radius may reproduce the displacement.

Dislocation of the Lower End of the Radius from the Ulna.

Sir A. Cooper, Malgaigne, and Hamilton, describe this injury as a dislocation of the lower end of the ulna from the radius; but, following the analogy of the nomenclature commonly received in other cases, it is preferable to call it, with Desault and Skey, a dislocation of the radius. The ulna is the fixed bone, the radius moves upon it; and it is by an abnormal increase of the natural motion of this bone that the displacement is produced. It may be caused by any injury which produces excessive pronation or supination of the hand; in the former case, the radius is dislocated forwards, the hand accompanies it, and the lower end of the ulna projects prominently backwards beneath the integument: this is rather the more common of the two; in the other the position of the bones is reversed. This luxation is not unfrequently accompanied by fracture of the radius, and cases are recorded in which the styloid process of the ulna has been thrust completely through the skin.

In whichever direction the dislocation has taken place, it is to be reduced by extending the hand, and pressing the radius and ulna into their natural relations to each other. They must then be retained by a compress, and straight splints should be applied for a time to the dorsal and palmar surfaces of the wrist.

Dislocations at the Wrist.

Dislocation of the hand from the lower end of the radius and ulna, though described by all surgical authors, from the time of Hippocrates till the commencement of the present century, as of frequent occurrence, is now known to be an extremely rare injury. Fractures of the inferior extremities of the bones of the fore-arm were generally mistaken for it, an error which was pointed out first by Pouteau, but more fully by Dupuytren. When it does occur, it is usually compound, or is associated with fracture of some portion of the lower end of the radius or ulna. A fall upon the hand is the common cause of this injury.

The displacement may be in either of two directions, backwards or forwards. In the dislocation *backwards,* the whole hand is placed on a plane posterior to the fore-arm; the upper end of the carpus forms a prominence on the dorsum of the wrist, and the lower end of the radius and ulna project on the palmar surface. The chief diagnostic mark between this injury and fracture of the lower ends of both bones of the fore-arm is derived from carefully noting the position of the styloid process of the radius and ulna, which in the one case will remain with the fore-arm, and in the other be carried backwards with the hand. Measurement also along the back of the hand, from the upper part of the carpal projection to the end of the middle metacarpal bone, in dislocation will give only the length of the carpus and metacarpus of the opposite side, while in fracture there will be at least an additional half-inch belonging to the separated fragments of the bones of the fore-arm. Now that the pathology and symptoms of fracture of the lower end of the radius alone are so well understood, there will be no probability of its ever being confounded with a luxation of the carpus. (See pp. 552 et sqq.)

In dislocation *forwards* the hand is displaced to the palmar side, and the inferior extremities of the radius and ulna form a well-marked projection upon the dorsum. This accident is one of excessively rare occurrence, although in the malformations known as "congenital dislocations" of the wrist, the displacement is far more frequently in this direction than in the other.

Treatment. Reduction is effected by simple extension, aided by pressure upon the carpus in the required direction. The hand should then be suspended in a sling until the ruptured ligaments have reunited; splints may be used if there is any difficulty in retaining the bones in good position.

Dislocations of the Bones of the Carpus.

The head of the os magnum occasionally suffers a partial luxation from the cavity formed for it by the scaphoid and semilunar bones. This is caused by violent flexion of the wrist, as in a fall upon the back of the hand. The unnatural projection on the dorsum of the carpus is easily recognised, and the bone may be pressed back into place, though it is retained with difficulty. A firm compress must be worn over it for some time.

Similar dislocations of some of the other carpal bones have been met with. Erichsen records cases of this injury to the semilunar and to the pisiform bone. The latter "was displaced by an effort to lift a heavy weight, and drawn up the arm to a distance of nearly an inch by the flexor carpi ulnaris."*

In the museum of St. George's Hospital is a curious specimen of compound dislocation of the semilunar bones of both sides, occasioned by a fall upon the hands from a great height. The bones were completely forced from their situation, through a wound on the anterior surface of the wrist, one of them merely hanging by a small shred of ligament.

A case is reported by Maisonneuve of simple dislocation backwards of the second row of carpal bones from the first, caused by a fall from a height of forty feet. The nature of the injury was verified by dissection.†

Dislocations of the Thumb.

Dislocations of the bones which compose this member are by no means unfrequent, as it is much exposed to injury in falls upon the hand. They may take place at either of its three articulations, and be either backwards or forwards, the former being by far the most common.

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* Op. cit. p. 281.

† *Mém. de la Soc. de Chirurg.* tom. ii.

1. *Dislocation of the first bone of the thumb (metacarpal) from the os trapezium.* This is less common than that of either of the other bones; it has been met with in both directions, and has generally been reduced without much difficulty by simple extension, though splints are sometimes required to maintain the bone in position. It may be mentioned here that a very few cases are on record of a partial luxation backwards of the proximal ends of some of the other metacarpal bones. F. H. Hamilton met with two; both produced in striking a blow with the clenched fist, and in each of which the bones corresponding to the index and middle fingers were affected.*

2. *Dislocation of the first phalanx from the metacarpal bone.* This injury is of more frequent occurrence; it is usually in the backward direction, *i. e.* the proximal end of the first phalanx lies on the dorsal surface of the distal end of the metacarpal bone. The deformity of the articulation is so well marked, that the diagnosis is unattended with difficulty. The cause is generally either a fall or blow upon the end or the palmar surface of the thumb.

Treatment. In many cases reduction is effected without any great difficulty, either by seizing the phalanx with the thumb and finger and making extension, or by forcibly bending it backwards and pressing upon the displaced extremity with the thumbs, while the flexor brevis pollicis is relaxed by flexing the metacarpal bone as much as possible into the palm. If these methods do not suffice, greater extending power may be gained by fixing a piece of tape or strong twine round the phalanx, by a clove-hitch knot, a wetted bandage or strip of adhesive plaster having been previously applied to protect the skin.

After a fair trial of all the above measures, reduction has still been unaccomplished in so many cases, that both the cause of the difficulty and the means by which it ought to be overcome, have become a standard subject for research and speculation among Surgeons of all countries. It will suffice here to say that, although much difference of opinion has certainly existed upon this point, the majority of writers have agreed that the flexor brevis pollicis muscle is in some way the chief obstacle to reduction. Dissection of dislocations artificially produced on the dead subject, shows that when the phalanx is completely carried on to the dorsal surface of the metacarpal bone, the two attachments of the flexor brevis, with their contained sesamoid bones, slip over its wide head, and tightly embrace its neck. It is evident that the bone can only be disengaged from this situation with difficulty. The only successful way hitherto devised to overcome this, is the subcutaneous section of one, or even both of the tendons of the muscle. The cause of occasional failure of even this somewhat severe proceeding is, I believe, the difficulty of effecting a complete division of all the opposing fibres. I have found, in the dead subject, that a division of the fascia which connects together the two sesamoid bones, by allowing the tendons to separate from each other, quite up to their insertion, materially facilitates reduction, without resorting to the section of the muscle itself; but I have not yet had an opportunity of trying this on the living. Dr. Humphry, also on anatomical grounds, recommends an endeavour to draw the sesamoid bones forwards, by means of blunt hooks inserted through an incision in the skin.*

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* Op. cit. p. 607.

In dislocation of the first phalanx forwards, reduction has always been easily accomplished, generally by forcibly flexing the thumb towards the palm.

3. *Dislocation of the ungual phalanx.* In this case the principal obstacle to reduction is the difficulty of getting a firm hold of the small displaced bone. Pressing its projecting proximal extremity forwards with the two thumbs will often reduce it, or the tape may be applied immediately above it, and then extension made, or it may sometimes be returned to its place by forcible flexion. Hamilton recommends "forced dorsal flexion in the case of the backward luxation, and forced palmar flexion in the case of the forward dislocation."

Dislocations of the phalanges of the fingers occur less frequently than those of the thumb. They are usually in the backward direction, owing to the mode in which the force is applied in falling on the end of one of the fingers, the most common cause of these accidents. The nature of the injury is readily recognised, and the reduction effected by simple extension applied in the manner recommended for dislocation of the phalanges of the thumb.

W. H. FLOWER.

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* *On the Human Skeleton*, 1858, p. 435.

INJURIES OF THE LOWER EXTREMITY.

THE seriousness of a lesion will depend partly on its nature, partly on its extent, and partly on its locality: in the latter respect, injuries of the extremities must rank in importance after those of the head and trunk, and lesions of the upper extremity after those of the lower.

The circumstances which render an injury of the lower extremity more serious than a similar one in the upper, are the greater size of the limb, and its greater distance from the centre of the circulation; so that although the mischief to be repaired is greater, the power to repair it is less: this is strikingly illustrated in lacerated and contused wounds of the foot, and in compound fractures of the leg, which are more prone to terminate in mortification than similar injuries of the hand or fore-arm. The suspension of the locomotive functions entailed by injuries to this part of the body, must also exert some influence on the circulation, and a retardative effect on the cure; while the comfort and occupations of a patient are more seriously interfered with than they would be by a corresponding accident to the upper extremity.

CONTUSIONS.

These may be considered as they affect the soft parts only; as they affect the bones; or as they affect both soft and hard tissues.

Contusions of the soft parts. If the skin and subcutaneous tissues are alone bruised, the symptoms and treatment will be the same as in similar injuries to these tissues elsewhere; but when the contusion affects the deeper textures, as the muscles, symptoms may arise resembling those of accidents of a totally different nature. This happens especially when the muscles which surround the large joints of the shoulder or hip are injured, which are liable to be confounded with fracture or dislocation in the neighbourhood of those joints. There can be little doubt that contusions about the hip have not only been mistaken for fracture of the cervix femoris, but have been paraded as examples of bony union having taken place without shortening of the limb. A case recorded in the

Gazette des Hôpitaux, tom. ix., is probably one of these. The patient was a female, 64 years of age, who was supposed to have an intracapsular fracture of the neck of the femur, and was treated for that injury; but was discharged at the end of a month perfectly cured, and without lameness. A somewhat similar case came under my notice about two years ago, in which a like mistake had evidently been made. The patient was a young man, twenty-four years of age, who was stated to have had impacted fracture of the neck of the femur; the symptoms immediately after the accident were, it was said, eversion, and shortening of the limb; though it was admitted no crepitus could be felt. He was confined to bed for a month, and a Liston's splint kept on; at the end of this time both thighs were of equal length, and perfectly symmetrical, voluntary movements of the limb were perfect, and executed with great force and vigour. The treatment of these muscular contusions consists in absolute rest of the part in the first instance, and friction of the surface subsequently.

Contusions of bone are far more serious than bruises of the soft parts, owing to the possibility of inflammation being set up, with all its consequences—suppuration, caries, necrosis. A blow on the shin may be followed by necrosis of the part struck, or of the entire shaft of the tibia; a fall on the trochanter, though not severe, is often sufficient, in scrofulous children, to set up destructive disease in the hip-joint; while a similar accident happening to the aged is not unfrequently followed by shortening and eversion of the limb, the result probably of the contusion, and subsequent interstitial absorption of the cancellous tissue of the neck of the femur.

Contusions involving all the structures of the limb are usually of so severe a character as to destroy the vitality of several of its structures; and in the treatment of such cases it becomes a primary consideration how far the efforts of nature are competent to repair the mischief; for it must be borne in mind, that we have to deal, not merely with a contusion, but with an injury which must before long become an open sloughing wound, endangering both the limb and the life of the patient. It is necessary, therefore, to decide at once on the course to be adopted; whether the extent of the injury, and the age and constitution of the patient, are such as to warrant an attempt to save the limb, or whether the opposite conditions call for amputation. In the majority of such cases, amputation is the only remedy; and it should be carried into execution before the constitutional irritation, which is sure to follow, has made its appearance.

Wounds.

There are certain circumstances, dependent on locality, which influence all wounds inflicted on this part of the body. Among those tending to an unfavourable issue, are—1st, the size of the parts wounded, which is more particularly seen in wounds of the blood-vessels and joints; 2dly, the dependent position of the limb, so that even trifling wounds heal less readily than they would do elsewhere; and lastly, the distance of its extreme parts from the centre of the circulation renders them, when injured, more prone to become gangrenous. On the contrary, the facility with which the limb may be placed in any position, or encircled by a ligature, for the purpose of either preventing absorption from a poisoned wound, or arresting hæmorrhage, and the ease with which most of its vessels may be secured when wounded, are so many circumstances which stand in favourable contrast with wounds inflicted on the head or trunk.

Contused and lacerated wounds of the lower extremity most frequently occur in connexion with fractures and gun-shot wounds, and are treated of respectively under those heads. When produced by other causes, and unaccompanied by fracture, the only respect in which the treatment would differ from similar wounds in other parts of the body, consists in the necessity of absolute rest of the limb during the greater part of the treatment. Incised wounds of the lower extremity, except when made surgically, are not of very frequent occurrence in civil practice; and, when met with, are generally found to have resulted from some accident in the use of the tools employed in certain trades. Thus the knee-joint may be opened by the slipping of a knife in cutting leather or wood placed between the patient's knees; the femoral artery may also be wounded in a like manner; and death has been known to result from a wound of this vessel by the breaking of a wine-bottle held between the thighs while drawing the cork. Ugly flesh-wounds are sometimes produced by the scythe in mowing. None of these, however, require any special treatment which is not laid down under the head of Wounds of Joints and Wounds of Arteries. Punctured wounds of the lower extremity have been observed to be more dangerous when affecting the sole of the foot than either the leg or the thigh; thus darning-needles, crochet-needles, &c. are not unfrequently buried in the soft parts of the leg and thigh, without setting up any mischief; but in the sole of the foot it is generally otherwise. Gross relates the case of a boy, nine years of age, who, while running about barefoot, trod upon a chicken-bone, a fragment of which nearly an inch long entered the sole of the foot, lodging deeply in the substance of the flexor muscles, in contact with the metatarsal bones. Pain and swelling followed; but the boy walked about for upwards of a fortnight. Suddenly symptoms of tetanus came on, and though every effort was made, by Professors Gross and Parker, to discover the foreign body, it could not be detected, and death followed a few days afterwards.*

SPRAINS.

Of all the joints of the body, none are so liable to these accidents as those of the lower extremity, and, of them, the ankle is by far the most frequently affected. This is sufficiently accounted for by the position and functions of this joint, the small size of its articular surfaces, the great weight the astragalus has to support, and the unyielding nature of the lateral ligaments. This natural tendency is probably still further increased by the modern fashion of wearing high- and narrow-heeled boots, which, by diminishing the base of support for the body, increases the tendency of the foot to become inverted or everted. The symptoms and mode of occurrence of sprains of the ankle may be illustrated by the following case. A gentleman, hastening to a steam-boat, was running rapidly down some steps leading to the river, when his foot became suddenly bent inwards, and he fell. The immediate effects of the accident were severe pain, and inability to bear any weight on the joint. Subsequently, swelling of the ankle took place; and lastly, ecchymosis made its appearance, and extended upwards and backwards on the outer side of the limb as high as the calf.

The situation of the ecchymosis will generally enable us to judge of the direction in which the force was applied; if the twist of the foot was inwards, the chief injury would be to the structures on its outer side, and there the subsequent ecchymosis would be most marked; if, on the contrary, it was bent in the opposite direction, the reverse would be the case. In slight sprains of the ankle, the ligaments are probably only stretched or slightly lacerated; but in more severe cases they may be completely torn through, and all the soft structures around the joint more or less injured. Mr. Wilson, in his Lectures on the Bones and Joints, states, that "in one case, where the patient died from the effects of the injury of another part, at the end of five days, I found the capsular ligament of the ankle-joint, and one of the lateral ligaments binding the tibia to the foot, lacerated. In another case, I have found the ligaments thickened, and having lost much of their pliability; and in some instances more vascular than usual, and evidently in a state of inflammation."

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* Gross, *System of Surgery*, vol. i. p. 373.

Sprains of the ankle are sometimes mistaken for fractures, and the latter for the former; the two injuries may also coexist. If there be much pain and swelling, an insufficient examination is sometimes made, and thus no accurate diagnosis is arrived at; subsequently, if the joint be slow in recovering, as is generally the case in severe sprains or in old subjects, patients are apt to believe that a bone has been broken, or is "out of place," which their medical attendant has failed to detect. It is desirable, therefore, in all cases to make a careful examination of the part injured, and to ascertain the precise nature of the accident at the first visit; careful manipulation of the joint, together with passive movements of the same in every direction, an examination, in fact, specially directed to the detection of fracture, will seldom fail to do so, should it exist. After this, should any doubt exist, let the patient have the benefit of it, and let the case be treated as for the more severe injury, since it is better that the treatment should be prolonged than that the patient should be maimed. The practice, moreover, has this advantage, that what is the proper treatment for a fracture is the best that can be employed for a sprain. Sprains of the knee are by no means uncommon, and are characterised by great swelling from the effusion of fluid within the joint. Sprains of the hip and other joints of the lower extremity are less common than those of the ankle and knee, and are not likely to be mistaken for other accidents. The former may, however, resemble incipient hip-joint disease, and may, indeed, lead to its occurrence; but the error of diagnosis, so far as regards treatment, is not of practical importance.

In reference to the treatment of sprains of the lower extremity, it must be regulated by their severity. In a severe sprain, attended with much pain and inflammation, leeches should be applied, followed by fomentations of water as hot as can be borne, or the application of a large hot linseed-meal poultice. If the ankle be the joint sprained, a piece of oil-silk, or gutta-percha cloth, may be placed outside the poultice, and the limb laid on a soft pillow; the ends of the pillow should then be brought together by two or three pieces of bandage formed into slip-knots, so as completely to surround and envelop the limb, which must be raised and supported. In slighter cases, rest, position, and cold lotions are often sufficient, and also more grateful to the patient's feelings than warm applications. In all cases, light pasteboard splints placed on the outer and inner aspects of the joint, over a wet bandage previously made to encircle it, afford support to the part, prevent motion, and give a sense of comfort and security to the patient.

FRACTURES.

It has been long known that fractures of the limbs are of more frequent occurrence than those of the trunk, but whether the upper or lower limbs are most liable to these accidents is a point not so well determined. Of 1800 fractures treated at the Pennsylvania Hospital from 1715 to 1838, 901 were of the lower extremity, and 572 of the upper. Of 1572 fractures at the Calcutta Native Hospital from 1815 to 1837, 681 were of the lower extremity, and 665 of the upper. Of 2328 fractures collected by Malgaigne from the registers of the Hôtel Dieu at Paris, 1006 occurred in the lower extremity, and 850 in the upper; giving, therefore, out of the total number of 4675 fractures of the extremities treated at these three institutions, a majority of 501 to fractures of the lower.* When we take into consideration, however, the fact that many patients with fracture of the upper extremity attend only as casual or out-patients, and so escape registration, it is highly probable that these injuries are quite as numerous, if not more so, than the corresponding ones of the lower extremity. This is quite borne out by the statistics of fractures collected by the late Mr. Lonsdale, at the Middlesex Hospital, between the years 1831 and 1837. During this period there were 1901 fractures, treated either as in- or as out-patients, and of this number only 516 were of the lower extremity, and 764 of the upper.† These figures probably indicate more correctly than the others the relative proportion of fractures occurring in the two extremities.

Fractures of the Femur.

These fractures, as compared with those of the other bones of the skeleton, stand about fifth in the order of frequency. They may occur in any part of the bone, though fractures of the shaft are by far the most common, and prevail at all periods of life; whereas fractures of the neck of the bone are almost peculiar to old age: the former occur most frequently in the male sex, the latter are slightly more frequent in the female.

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* Malgaigne, *Traité des Fractures et des Luxations*, tom. i.

† Lonsdale, *Practical Treatise on Fractures*.

Fractures of the neck and upper part of the femur may take place entirely within the capsular ligament or external to this structure, or they may be situated partly within and partly without the ligament; or, lastly, they may take place through the great trochanter only.

Fractures of the neck of the femur within the capsule present several varieties, both as regards their situation and direction. The breach of continuity may take place close to the head of the bone, at the point of attachment of the capsular ligament, or at any intermediate part; it may be transverse in direction, more or less oblique, or impacted, the upper end of the lower fragment being usually forced into the cancellous tissue of the upper; or, lastly, there may be a mutual impaction. The cervical ligament may also present different degrees of injury; it may be partially or completely torn through, or, what is more rare, not torn through at all; but however slight the injury it may have suffered, some blood is usually poured into the joint, and more or less inflammation set up in the synovial membrane. This gives rise to an increased secretion of synovia, mixed with flakes of lymph, which subsequently becomes absorbed, and the fractured surfaces united by a fibrous or fibro-cartilaginous tissue; or union may not take place at all. One of the most important facts in connexion with intracapsular fracture is its non-union by bone; the exceptions to this are so rare that they rather prove the rule than otherwise. Sir A. Cooper, who first pointed out and fully established this fact, does not deny the possibility of bony union; but he asserts that it requires such a combination of favourable circumstances as is very rarely met with; thus, it may take place "when the fracture is through the head of the bone, with no separation of the fractured ends; when the bone is broken without its periosteum being torn; or when it is broken obliquely, partly within and partly external to the capsular ligament."* The two principal reasons for this want of union by bone are, first, the difficulty or impossibility of keeping the fragments in apposition; and secondly, the imperfect nutrition of the upper fragment, owing to its isolation from the rest of the bone: to these may be added, the atrophy of the cervix, and the general want of constitutional vigour which always accompanies old age. The changes which are met with in the joint, in old-standing cases of fracture of the neck of the bone, are very various. One of the most constant is a great thickening and condensation of the capsular ligament, with occasionally a deposit of osseous matter in its structure. The synovial membrane also exhibits the effects of inflammation, and is much thickened; but it is in the two fragments of the bone itself that the most remarkable changes are observed. Thus, the upper fragment, which remains attached to the acetabulum by the ligamentum teres, may have its broken surface hollowed out and eburnated, so as to form a supplementary socket, in which plays the rounded, smooth, eburnated, but shortened stump of the lower fragment, the two fragments having thus formed a false joint of the true ball-and-socket type; or the two surfaces may be concavo-convex, and so adapted to each other as to admit of a considerable amount of motion between them; or the fragments may be partially united by elongated bands, which allow of the free movement of the lower fragment. Sometimes all movement between the fractured surfaces is prevented by their close and firm union by fibrous tissue. In all cases absorption takes place, generally to a considerable extent, in one or both fragments.

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* Sir A. Cooper *on Dislocations and Fractures of the Joints*, ed. 1842, p. 137.

The immediate causes of an intracapsular fracture are frequently very slight; a common one is slipping off the curb-stone. The sudden jerk breaks the neck of the bone, and the patient falls to the ground; the fall being, according to Sir A. Cooper, a consequence of the fracture, and not the cause. The injury may, however, ensue from a fall on the great trochanter, or from a sudden movement of rotation of the body while the limb is prevented moving with it. By a series of experiments made by M. Rodet on the os femoris, and on plaster-casts of the bone, he arrived at the conclusion that all intracapsular fractures are caused by a force acting in one of the following directions. 1. Vertically, as by falls on the feet, *e. g.* slipping off the curb-stone; 2. in an antero-posterior direction, either by blows or by a forcible rotation of the bone in this direction; 3. in a postero-anterior direction, by blows or forcible rotation. But this gentleman goes even further, and maintains that not only the seat, but the direction of the fracture is indicated by the direction in which the force has acted. Thus, a force acting vertically will produce an oblique intracapsular fracture; a force acting from before backwards, a transverse intracapsular fracture; one from behind forwards, a fracture partly within and partly without the capsule; and a force applied transversely, a fracture entirely without the capsule; thus, in falls directly on the trochanter, the fracture, according to M. Rodet, is always without the capsule.* Malgaigne, however, observes very truly, that in falls on the side the trochanter is rarely struck in a transverse direction, owing to the inclination of the cervix femoris backwards, as well as downwards and outwards; so that, in point of fact, it would be the anterior edge of this process which would be struck, and the direction of the force would be from before backwards, and from without inwards.

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* *L'Expérience*, 14 mars 1844.

The cases, then, of intracapsular fracture from falls on the trochanter are rather confirmatory than otherwise of the truth of M. Rodet's hypothesis.

The remote or predisposing causes of fracture of the cervix femoris, and the connexion of the accident with old age, are to be sought for in the impaired nutrition, and the altered chemical composition and direction of the neck of the bone which then prevail. It was formerly supposed that the neck had become more brittle through the preponderance of the earthy material of bone, which was known to be relatively increased in all bones as age advanced; but Mr. Bransby Cooper showed that the quantity of bone-earth in the neck of the thigh-bone of the aged was diminished instead of being increased: thus, the average quantity in the necks of five middle-aged bones was 50·1 per cent, in three old bones, 33·5, and in five old bones whose necks had been fractured it was only 23·9 per cent. The shafts of the same bones contained respectively 56·7, 55·5, and 50·1 per cent of bone-earth.* Too much stress has likewise been laid on the altered direction of the neck of the bone, which, it was affirmed, became less oblique as age advanced, till it formed a right angle with the shaft. Mr. Canton has shown that this is not correct, and that the obliquity of the neck varies very slightly, the few cases in which it has become horizontal being altogether exceptional: the cortex, however, is always thinner, and the cancelli larger, and frequently filled with an oily fat.† It is chiefly, then, to the change of nutrition, senile atrophy, with sometimes well-marked fatty degeneration, that must be attributed the greater frequency of fracture of the cervix femoris at this period.

The *symptoms* of a fracture within the capsule are the following: 1. *Shortening of the limb.* This varies in recent cases from about a quarter of an inch to an inch, and can be overcome by making extension. The variation probably depends on the kind of fracture, the extent to which the cervical ligament is torn, and the impaction or otherwise of the fragments. This amount of shortening is less than what is given by Sir A. Cooper, who says the leg becomes from one to two inches shorter than the other; but as he directly afterwards affirms that the difference in the length of the limbs is best observed by placing the patient on his back and comparing the ankles, one must admit with considerable reserve a statement based on so loose a method of measurement. Smith affirms that the amount of immediate shortening varies from a quarter of an inch to an inch; and in this he is supported by Malgaigne, who declares that the capsular ligament and the trochanter minor both oppose a greater shortening than one inch, and that this is the maximum which can take place; while MM. Brun and Rodet, in experimenting on the dead body, never succeeded in producing a greater amount of shortening than two-thirds of an inch. These remarks, it must be clearly understood, refer only to recent fractures; in those of long standing the permanent shortening is usually greater, as will be explained hereafter. It sometimes happens that there is no shortening in the first instance; but that this symptom makes its appearance gradually or suddenly, some days, and even weeks after the accident; indeed, cases have occurred in which there has been no shortening, and the fracture has only been discovered after death. Sir Benjamin Brodie dissected a case in which the cervix was obliquely broken, and in which the upper part of the bone prevented the ascent of the lower. Mr. Stanley also relates the following case: "A man aged sixty was knocked down in the street; he complained of pain in the hip, but there was neither shortening nor eversion of the limb, and its several motions could be executed with perfect freedom and power. A fracture was not suspected; the patient, therefore, was merely confined to his bed. In the fifth week from the date of the accident he died from another cause. No trace of injury was found in the parts around the hip-joint, but small effusions of blood, apparently not recent, were discovered beneath the synovial and fibrous membrane, covering the neck of the femur, also beneath the synovial membrane covering the ligamentum teres. The head and neck of the bone were sawed through their middle, and in each portion a dark line, evidently occasioned by the effusion of blood, was seen extending through the bone at the base of the neck. A fracture was discovered extending along this line; but the broken surfaces were in contact, and the synovial and fibrous membrane covering the neck of the bone was uninjured. In this case," Mr. Stanley very pertinently remarks, "if an attempt had been made to walk at the end of two or even three weeks from the accident, a separation of the fractured surfaces, and consequent shortening of the limb, would have been the result."* The sudden occurrence of shortening, then, must be ascribed to the displacement of the fragments, consequent on some movements of the limb which have torn through the hitherto uninjured periosteum of the neck, and unlocked the serrations of the fractured surfaces; while the gradual shortening of the limb is probably owing to the gradual absorption of the neck of the bone.

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* *Guy's Hospital Reports*, 1845, 2d series, vol. iii.

† Canton, *Surgical and Pathological Observations*, p. 33.

2. *Eversion of the limb.* This is the next most prominent symptom of a fracture of the cervix femoris, and it is usually attributed to the preponderating power of the external rotator muscles of the thigh over those which rotate it inwards; it may also be due to the mere weight of the limb, and its natural inclination to gravitate outwards. But there is another cause, which seems to have been hitherto overlooked, viz. a mechanical one; cases are met with in which the limb retains the position into which it was thrown by the accident, independent of muscular action and of its own gravity. Let us suppose the cause of the fracture to be a sudden rotation of the limb outwards, the fracture taking place at the moment of most extreme rotation; then, the form and position of the fragments may be such as to retain the limb abnormally everted, and oppose its rotation inwards.

A patient lately under the care of the writer fractured his left cervix femoris by slipping on a piece of wet slate. When seen a few hours afterwards, he was lying inclined on his left side, with the leg and thigh completely everted, but not shortened. Although all the other symptoms of a fractured cervix were present, his age (only fifteen), and the absence of shortening, were against this supposition; he was therefore treated for a few days by simply confining the limb to the bed by junks and bandage. At the end of this period, there being no alteration or abatement of the symptoms, he was brought under the full influence of chloroform, and well-marked crepitus was detected in the joint. All muscular resistance was for the time annihilated, yet rotation inwards to a sufficient extent to place the limb fairly on its posterior aspect, and parallel with its fellow, could not be effected. It is clear that this was not a case of impacted fracture, or the limb could not have retained its normal length, neither would impaction interfere with the rotation of the limb. But the strongest argument in favour of a mechanical cause is the occasional occurrence of inversion of the limb in these fractures. It has been attempted to explain even this phenomenon on the muscular theory, by asserting that the direction of the fracture is such as to leave the small external rotator muscles in connexion with the upper fragment, while the internal rotators, the tensor vaginæ femoris, and the anterior portions of the gluteus medius and minimus muscles, remaining attached to the lower, roll the limb inwards; but this is not only ignoring the existence of the psoas and iliacus, the pectineus and the adductor muscles, but is assuming that the fracture in these cases is always similarly directed with reference to the muscles; this, however, has been disproved by numerous autopsies, and notably by those in which the fracture was found to be entirely within the capsule. It would seem, then, that when the limb is fixed, either in an everted or an inverted position, the fixation cannot be due to the muscles, or to its own gravity, but rather to the form and position of the fragments, and sometimes, perhaps, to their impaction, the upper fragment being so placed with reference to the lower as to offer a mechanical obstacle to the rotation of the latter, either in one direction or the other.

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* *Medico-Chirurgical Transactions*, vol. xiii. p. 511.

It is much to be regretted that in the numerous examples of fracture of the neck of the femur, with inversion of the limb, now upon record, more precise details of the exact direction of the fracture, and how it was caused, are not given; but there is this much in evidence on the position of the fragments, viz. that the lower is in front of the upper. "In every case of fracture of the neck of the femur accompanied by inversion of the foot," observes Smith, "which I have had an opportunity of examining after death, the inferior has been placed in front of the superior fragment." So likewise Dupuytren, who goes a step further: "Si le fragment interne se porte en arrière, et l'externe en avant, il y a alors déviation en dedans; si, au contraire, la fracture est oblique, en sens inverse, la déviation aura lieu en dehors."* Cruveilhier also has recorded a case of fracture with inversion, in which, after death, this relative position of the fragments was found.† More extended and accurate observations will probably show that all fractures of the neck, attended with fixation of the limb, either outwards or inwards, have been caused by extreme and sudden rotation of the limb in one or other of these directions.

3. *Position of the trochanter major.* It would result from the shortening and eversion of the limb that this process must be situated somewhat higher and more posteriorly than natural, so as to project less than on the sound side. When the limb is rotated, the trochanter describes a lesser arc than in an unfractured cervix—an arc

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* *Leçons Orales*, tom. ii. p. 109.

† *Anat. Path.* livr. xxvi.

small in proportion to the shortness of the neck left attached to it; hence the situation and movements of this process are available as a means of diagnosis.

4. *Crepitus.* The absence of this symptom by no means proves the non-existence of fracture, though its presence is conclusive in its favour. There are several circumstances which may prevent crepitus being felt; one of these is the drawing up of the lower fragment,—hence Sir A. Cooper directs the limb to be first drawn down and then rotated; another is the impaction of the fragments; and a third, the forcible action of the muscles resisting rotation: indeed, unless the patient be faint, or very feeble, or under the influence of an anæsthetic, it is often impossible to elicit this symptom without using a degree of force which would be unjustifiable.

5. *Loss of power in the limb.* When a person has fractured his cervix femoris by a fall, or has fallen in consequence of the fracture, he is usually unable to rise, and should he succeed in doing so, he again falls. There are, however, some notable exceptions, in which patients have not only risen from the ground but walked after the accident. These peculiarities are difficult to account for; some have attempted to explain them on the supposition of an interlocking of the fragments, others of impaction; and others, again, of the resistance offered by the uninjured periosteum of the neck of the bone; but against all these hypotheses must be placed this fact, that loss of power of the limb sometimes exists without displacement of the fragments, and a considerable amount of power has been observed with displacement. Usually, the want of voluntary power over the limb is complete, and passive movements are attended with pain and difficulty.

6. *Swelling and pain.* There is rarely much swelling in this accident, and only a moderate amount of pain, while the limb is at rest; but all movements, especially those of rotation or of direct flexion, are attended with considerable suffering. The pain is most felt in the groin and behind the trochanter, and is increased by pressure in these situations.

Fractures of the cervix femoris external to the capsular ligament. The normal type of a simple extracapsular fracture may be said to pass through the neck of the bone, obliquely, at its base, being bounded above and below by the two trochanters, and anteriorly and posteriorly by the intertrochanteric lines, with which it is parallel. If the fracture be more horizontal in direction, it will pass through the trochanter major, which will thus be separated into two portions; the upper remaining with the neck of the femur, and the lower with the shaft of that bone. Both of these varieties are rare; more usually the fracture is multiple or comminuted, the trochanter major being split through, or detached, or broken into several fragments, while in others the lesser trochanter is likewise separated. Usually the neck of the bone is broken through at its base, "the trochanter major split, and the neck received into its cleft."

The most common cause of the fracture is a fall from a height, or with great violence, on the trochanter major; this first breaks the neck of the bone, which is then driven into the cancellated tissue between the trochanters, and acts like a wedge in splitting, or even detaching entirely, one or both of these processes. Nearly every case, therefore, of extracapsular fracture is, in the first instance, impacted; and "it depends principally upon the violence with which the injury has been inflicted, whether the neck of the bone shall remain implanted between the trochanters, or whether these processes shall be so separated from the shaft of the femur as to allow of the escape of the cervix from the cavity which it had formed in the reticular tissue of the lower fragment. If the force has not been very great, the neck of the femur remains wedged in between the trochanters, and one or both of these processes are split off from the shaft; but if the fibrous structures before alluded to (which invest the whole of the trochanteric region) have not been njured, these broken portions of the trochanters are still held firmly n their places, and the impacted cervix does not become loosened; but if the force has been considerable, the impulse prolonged, the bone in a state of senile atrophy, or if, as frequently happens, the patient in endeavouring to rise falls a second time, then, under hese circumstances, the trochanters are not only broken from the shaft of the femur, but are so far displaced and separated from their connexion with the soft parts, that the cavity, or socket, as it were, nto which the superior fragment has been received, is destroyed. The impacted cervix, thus set free, no longer opposes the ascent of he inferior fragment, and the case then presents the characters of he ordinary extracapsular fracture, with great shortening of the mb."*

These extracapsular fractures present a remarkable contrast to he intracapsular in their subsequent progress, inasmuch as bony nion is the rule instead of the exception; nevertheless, even in hese it is a slow process, and the consolidation of the trochanters to the shaft takes place long before that of the opposed surfaces of the fractured neck and of the shaft. A remarkable feature connected with the consolidation of these fractures is the great exuberance of ossific deposit, which frequently takes place in the neighbourhood of the trochanters, and is supposed to have relation to the comminution and separation of the fragments of these processes.

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* R. W. Smith *on Fractures and Dislocations.*

Symptoms and diagnosis. The symptoms of this accident so nearly resemble those of intracapsular fracture, that it is exceedingly difficult, and sometimes impossible, to distinguish one form of injury from the other. In extra- as in intra-capsular fractures there is shortening of the limb, eversion, crepitus, swelling, and pain; but as these symptoms are common to both accidents, it has been sought to distinguish them by other signs,—as the age of the patient, the degree and direction of the force which caused the fracture, or by the greater prominence of some one symptom in one form of fracture than in the other. Thus, according to Sir A. Cooper, if the subject of the injury were over fifty years of age, or if the fracture had arisen from a comparatively slight cause, it would be intracapsular; but, under the opposite circumstances, extracapsular. He adds, however, "both fractures occur in age, and therefore no conclusion can be drawn between the two, in advanced age, but by the most careful examination." M. Rodet considered he had found a clue to the diagnosis in the direction of the force which produced the fracture; while Smith is "satisfied that the degree of shortening of the limb may, *with certain precautions*, be considered as diagnostic of the seat of the fracture; and that it is greater when the lesion of the bone is external to than when it is within the capsular ligament."

The circumstances which influence the amount of shortening in intracapsular fracture have been already pointed out; in extracapsular fracture, it is the impaction or non-impaction, or degree and angle of impaction, of the fragments on which the difference mainly depends. In impaction, which is the rule, the shortening is generally from half to three-quarters of an inch, as stated by Sir A. Cooper; but where there is no impaction, as in fractures caused by great violence, the limb may be shortened to as great an extent as in fractures of the shaft. If, then, in a recent fracture of the cervix femoris, the limb were found to be an inch and a half or two inches shorter than its fellow, there could be little doubt of the fracture being without the capsule, though shortening to a less extent than an inch would by no means indicate that it was within that structure. It would seem from this that shortening can only be of value as a diagnostic sign in the exceptional circumstances just referred to, and that in the majority of fractures of the neck, in which the shortening does not exceed an inch, it is of no value in diagnosis. Another sign, to which some importance has been attached, is the degree of facility with which the limb may be restored to its normal length by traction: in intracapsular fracture, this is stated to be easy; whereas in extracapsular fracture, owing to the impaction of the fragments, it cannot be accomplished without great force. When treating of intracapsular fracture, we adverted to the occasional absence of all shortening for some time after the occurrence of the accident: this peculiarity has been seized upon by certain Surgeons as a sign of great value in distinguishing one form of fracture from the other. In extracapsular fractures, they affirm, there is always impaction, and therefore shortening,—an assertion which is at least open to dispute; but, even granting it to be so, the extreme rareness of intracapsular fractures without shortening would render this sign of comparatively little value.

None of the above signs, then, can be depended on, not even the failure to restore the limb to its normal length by traction; for this may depend on other causes than impaction, such as muscular resistance, or insufficient traction.

There are, however, two symptoms of extracapsular fracture, which, when present, are conclusive of the nature of the injury. First, abnormal mobility and displacement of the great trochanter; and secondly, an immediate shortening of the limb, to the extent of an inch and a half or two inches.

With reference to the diagnosis of either of these varieties of fractured cervix femoris from other injuries, it is usually easy; exceptions, however, are now and then met with in which considerable difficulty occurs. In the first place, many of the symptoms of this accident may be present in other lesions than fracture of the neck of the femur; secondly, there may be an absence of most of the symptoms of fracture of the neck of the bone, notwithstanding that that lesion actually exists; or thirdly, the fracture may be accompanied by symptoms which resemble those of some other injury.

The accidents which are most liable to be confounded with fractures of the neck of the femur, are certain fractures of the pelvis,—dislocations of the head of the femur upon the pubes,—and severe contusions of the hip; while among diseases may be named chronic rheumatic arthritis, absorption of the neck of the thigh-bone, and paralysis. The particular lesions of the pelvis which most nearly resemble fractures of the cervix femoris are fractures of the acetabulum. The bottom of this cavity may be driven into the pelvis, together with the head of the femur; or a portion of its margin may be broken off, so as to allow of the escape of the head of the femur upon the ilium; or lastly, it may be broken without having its fragments displaced. Each of these fractures gives rise to symptoms which, in one case, may resemble a dislocation of the femur; in another, a fracture of the neck of that bone. In the two first there is in fact a real dislocation, consequent on the fracture; and it is this complication which renders the true nature of these injuries oftentimes so obscure. Thus there will be shortening of the limb, with inversion or eversion, as the case may be; more frequently the former, and so more nearly resembling a dislocation; but then there will be crepitus, the power of restoring the length of the limb by traction, and the return of the shortening when this is discontinued, all which are characteristic of a fracture. In the fractures of the acetabulum without displacement, the symptoms likewise very closely simulate those of a fracture of the neck of the femur, the absence of shortening of the limb and of crepitus being the only difference; and these symptoms we have seen are not always present in this injury. The diagnosis, then, of these several injuries is by no means easy, though not impossible; and to this we may sometimes be guided by the history of the accident, the age of the patient, and the mixed character of the symptoms. Practically, perhaps, a mistake of diagnosis is of no great moment, as the treatment is nearly the same for all of these accidents, and it may be observed that the real nature of some of them was only discovered after death.

The symptoms by which a dislocation of the head of the femur upon the pubes may be distinguished from the fracture in question, will be pointed out, when treating of that dislocation. A severe contusion of the hip more nearly resembles a fracture than would at first sight be imagined; thus, there may be pain, swelling, ecchymosis, eversion of the limb, with loss of power, and altered position of the great trochanter; and, though crepitus and shortening are wanting, we have seen that these symptoms are sometimes wanting in fracture. In all injuries of this ambiguous character, time and rest eventually clear away doubt; still, as prolonged uncertainty is undesirable, chloroform should be administered, and a careful examination made while the patient is under its influence. Should a fracture exist, crepitus may perhaps be elicited, and on the recovery of the patient from the anæsthetic, the limb will probably be found to have become shortened; on the contrary, should the limb preserve its normal length, should its movements be found perfect, and unaccompanied by crepitus, we may infer the non-existence of fracture.

Chronic rheumatic arthritis gives rise to symptoms which very closely resemble those of a fracture of the cervix femoris, as exemplified in the following case: "A woman of advanced age was admitted into the Richmond Hospital, having sustained an injury of the hip from a fall upon the trochanter. On examination (the patient having been placed in the horizontal posture), the affected limb was found to be one inch shorter than the sound one; the foot was everted; flexing the thigh upon the abdomen caused considerable pain; and the patient was unable to raise the heel from the bed. From these symptoms it was suspected that the neck of the femur had been broken; upon further examination, however, it was found impossible to produce crepitus, or to restore the limb to ts natural length by extension; hence it became evident that the ase was one either of impacted fracture of the neck of the femur, or of contusion of a joint previously the seat of chronic rheumatism. Upon being questioned, the woman stated that she had for a long period suffered from pain and stiffness in the hip-joint; that the pain was more distressing in wet weather and towards evening, but was relieved by a night's rest; that she had gradually become ame, and had been for some time obliged to make use of a stick when walking. The case was therefore supposed to be one of contusion of the hip-joint combined with chronic rheumatism, and he event proved the correctness of the diagnosis."*

In this case the history showed that the disease had existed prior to the accident, and the diagnosis was therefore simplified; but it not unfrequently happens that the morbid changes, the intertitial absorption of the neck of the thigh-bone, the alteration of the ngle which it forms with the shaft, the flattening and expansion of ts head, and the consequent shortening of the limb, and lameness, re first set up by a blow or fall on the great trochanter; and it may ecome a question at a future time whether the bone was not really roken, the nature of the injury having been overlooked or misken. A careful examination shortly after the accident will seldom il to discover its true nature; but old cases of interstitial absorpion of the neck of the femur, following a blow on the trochanter, annot be distinguished from old fractures of the same part. Orinary hemiplegia, or paralysis of the lower extremity, can scarcely e mistaken for a fracture; yet certain cases of infantile paralysis bear some resemblance to it: thus, a child while running about will suddenly fall down and complain of being hurt, and, being put on his feet, it is found he has lost the use of one leg. After a time the limb becomes shortened and everted, and the prominence of the trochanter on that side is diminished.

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* Smith *on Fractures and Dislocations*, p. 113.

Apart from the rareness of a fracture of the cervix femoris in a young child, it must be remarked that most of the above symptoms only manifest themselves some months after the attack of paralysis, and are the result of atrophy of the limb, which ceases to grow at the same rate as the sound one. Examined immediately after the fall, it will be found to be simply paralytic, and there will be an absence of all the usual symptoms of fracture. But if certain accidents and diseases bear some resemblance to a fracture of the neck of the femur, so may this injury be sometimes unaccompanied by many of the symptoms which ordinarily characterise it. An example of this was given at page 597, and it may be remembered that the true nature of the lesion was only discovered after death. There are no signs by which such an injury could be recognised during life: the mode in which it happened, the age of the patient, and the pain within the joint, might lead to a suspicion of its nature, but nothing more. Such cases, however, are so rare, that nothing more need be said respecting them; but they suggest great caution in regard to the treatment of doubtful cases.

In reference to the occasional resemblance of a fracture of the cervix femoris to some other injury, it will be pointed out hereafter (see Dislocations of the Hip) how a fracture, with inversion of the foot, or the drawing up of a detached fragment of bone towards the ilium or ischium, may resemble some of the more prominent symptoms of a dislocation of the femur.

Prognosis. Whether a fracture of the neck of the femur be situated within or without the capsular ligament, the prognosis must always be guarded; lameness, in a greater or less degree, is inevitable in both varieties; but the danger to life is not small, especially in the extracapsular fractures, the chief causes of death being shock, irritative fever, or gradual exhaustion of the vital powers. With reference to the proportion of deaths to recoveries, the tables of the Hôtel Dieu show a mortality of nearly one-third: but this is evidently much too high, and is attributable, according to Malgaigne, to the treatment pursued in that institution. The period at which death ensues will be seen in the following analysis of sixty specimens of fractured cervix, contained in the museums of the

Richmond Hospital and the Richmond School of Medicine, in Dublin, and described by Mr. R. W. Smith. Of these sixty specimens, thirty-two were situated within the capsular ligament, and twenty-eight without, and of the individuals from whom the former were taken,

13 died within 2 months.
10 ,, ,, 1 month.
6 ,, ,, 2 weeks.

Of the subjects of extracapsular fracture,

19 died within 2 months.
17 ,, ,, 1 month.
11 ,, ,, 2 weeks.

Fractures of the femur, partly within and partly without the capsular ligament. A very oblique fracture through the neck of the femur will necessarily be of the above description, and, as has been shown by Sir A. Cooper, the part of the fracture beyond the capsule will unite by bone, and that within by ligament only. I am not aware of any sign by which such an injury may be certainly diagnosed, so that its real nature is only discoverable after death; the fact, however, that such injuries do occur, and that they may be partially united by bone, is sufficient evidence in favour of the practice of treating all fractures of the neck as if they were extracapsular.

Fractures of the femur through the trochanter major. "Oblique fractures," observes Sir A. Cooper, "sometimes happen through the trochanter major, without implicating the neck of the bone." "The first case of this kind I ever saw," he continues, "was in St. Thomas's Hospital, about the year 1786. It was supposed to be a fracture of the neck of the thigh-bone within the capsule, and the limb was extended over a pillow rolled under the knee, with splints on each side of the limb, by Mr. Cline's direction. An ossific union succeeded with scarcely any deformity, except that the foot was somewhat everted; and the man walked extremely well. When he was to be discharged from the hospital, a fever attacked him, of which he died; and upon dissection the fracture was found through the trochanter major, and the bone was united with very little deformity; so that his limb would have been equally useful as before." This fracture appears, from the engraving, to be situated just below the anterior intertrochanteric line, and to intersect the trochanter near its centre, leaving part of this process connected with the neck of the bone, and the other part with the shaft.

Should a fracture traverse the bone a little higher, or a little less obliquely, it would necessarily pass through a portion of its neck (and so resemble one of the forms of extracapsular fracture), as happened in Mr. Stanley's case, quoted by Sir A. Cooper, in illustration of the injury we are now considering. This scarcely accords with Sir Astley's definition of this accident, and has probably given rise to Malgaigne's criticism, that he has confounded the fracture of the great trochanter with that variety of fracture of the neck of the bone in which the process in question forms part of the superior fragment. Sir Astley has given no other dissections of this accident than the two just named; but he relates several cases in which the injury was supposed to be of this nature. Its distinguishing marks are, "a fixed state of the upper part of the trochanter, whilst its lower part obeys the motion of the thigh-bone; eversion of the foot, and the very perceptible altered position of the trochanter major; crepitus felt, if a rather free movement be made of the upper part of the limb, and very little diminution of its length. But when the fracture happens below the insertion of the principal rotatory muscles, the lower portion of bone is much raised by the action of the gluteus maximus, and the limb becomes very much shortened and deformed at the place of union by exuberant callus." The treatment need not differ from that which is proper for fractures of the neck of the femur.

Fracture of the epiphysis of the trochanter major. In the foregoing section it has been shown that a simple fracture may extend through the trochanter major, either from the shaft or the neck of the femur; it has also been shown that this process is generally broken, and sometimes comminuted, in extracapsular fractures of the neck of the bone; the above title, however, would imply that it may be fractured independent of the shaft or neck of the femur, and of this there is certainly not sufficient evidence. The trochanter may, however, be separated from the femur, by violence, at an early period of life, before it has become united with the rest of that bone by osseous matter, as in the following case, communicated to Sir A. Cooper by Mr. Aston Key:

A young girl, about sixteen years of age, in crossing the street tripped, and, in falling, struck her trochanter violently against the curb-stone. She immediately rose, and, without much pain or difficulty, walked home; but experiencing an increase of pain, she was admitted, five days afterwards, into Guy's Hospital, and was examined by Mr. Key. The right leg, which was the one injured, was considerably everted, and appeared to be about half-an-inch longer than the sound limb. It admitted of passive motion in all directions; but abduction gave her considerable pain. She had perfect command over all the muscles, except the internal rotators. No crepitus, or displacement of bone, could be detected on the closest examination. Nine days after the accident she died. The post-mortem examination revealed a fracture which had detached the trochanter from the body and neck of the bone, but without tearing through the tendons attached to the outer side of the process; this so effectually prevented all motion of the fractured portion that the injury could not have been detected during the life of the patient.

Treatment of fracture of the neck and upper part of the femur. The most striking deformity occasioned by fracture of the neck of the femur being shortening and eversion of the limb, the indications would be to remove these by extension and rotation, and then to maintain the limb in its restored position, till ligamentous union shall have taken place in the one form of fracture, and osseous in the other. When, however, these principles are attempted to be carried out in practice, difficulties are encountered which have hitherto proved insurmountable; the limb, it is true, may be restored to its normal length, but the tractive force necessary to maintain it thus is greater than the patient can bear. Apart, however, from these considerations, there is some reason to believe that if the above indications were capable of being carried out, the broken fragments would be less favourably placed for union than if only a moderate extension were made. Malgaigne, wishing to test the effect of traction in an extracapsular fracture, carefully exposed the injured parts in the dead body, and then made extension and counter-extension from the limb and pelvis, as effected by the contrivances of Desault, Boyer, and others. The results were, that "the angle between the cervix and shaft of the bone became inordinately widened, then the cervix was disengaged from the lower fragment into which it had penetrated, and finally the trochanter was separated from the other two fragments; so that the contact and the normal relations of the three were destroyed, and consolidation would have been utterly impossible." Traction, then, to this extent ought not to be made; but the eversion of the limb should, as far as possible, be corrected, and the broken fragments kept in contact and immovable.

With reference to the treatment of intracapsular fracture, "I should," says Sir Astley Cooper, "if I sustained this accident in my own person, direct that a pillow should be placed under the limb throughout its length; that another should be rolled up under the knee, and that the limb should be thus extended until the inflammation and pain had subsided. I should then daily rise and sit in a high chair, in order to prevent a degree of flexion which would be painful; and, walking with crutches, bear gently on the foot at first, then gradually more and more, until the ligament became thickened, and the muscles increased in their power." . . . . "In every case, however," he very properly adds, "in which there is the smallest doubt whether it be a fracture within, or external to, the ligament, it will be proper to treat the case as if it were external."* Both these forms of fracture, as well as the other varieties we have spoken of, are now usually treated with the limb in the straight position, in the manner to be hereafter described when treating of fractures of the shaft of the femur.

Fractures of the shaft of the femur. These occur most frequently in its middle third. Of 70 cases observed by the writer, 46 were broken in this situation, 16 in the lower third, and 8 in the upper. Indirect violence occasioned the majority of these fractures; but of those due to direct causes the greatest number, both absolutely and relatively, occurred in the middle third of the bone.

It has been disputed whether a fracture of the shaft of the femur can be produced by muscular action; but of this many instances are on record, in which the production of the fracture cannot be explained in any other manner. Thus Beauchère has given an account of a man, 34 years of age, who, while sliding, felt himself in danger of falling backwards, and made a violent effort to keep up; he did not fall, but he heard at the instant a crack high up in the right thigh, which was found to be broken below the trochanters.†

The mode of production of this fracture will influence to a certain extent its character and direction: thus it may be multiple, or comminuted, or compound, if caused by machinery or the passage of a heavy weight over the thigh; transverse in direction, if caused by a sharp blow, and more or less oblique by a fall on the feet, or under a heavy load. The direction and degree of obliquity vary greatly; in the upper third of the bone the prevailing direction, according to Malgaigne, is downwards and inwards; in the middle third of the bone, according to the same author, it is down-

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[*] Sir A. Cooper, op. cit. pp. 162, 163.

[†] Beauchère, *Journ. de Méd. de Leroux*, tom. xxx. p. 336.

wards and forwards; while in the lower third, we are assured, it is more prone to assume a transverse direction, and oblique fractures are more rare, and not very constant in direction; thus, they may run downwards, outwards, and forwards, or downwards and inwards, or downwards and forwards; or there may be impaction of the upper fragment in the lower. Perhaps the most common direction is downwards and forwards, and the most rare downwards and backwards. In whatever part of the shaft the fracture may be situated, and whatever may be its direction, it is rare that displacement of the fragments does not occur, the lower fragment being drawn upwards, behind, and generally a little to the inner side of the upper; and sometimes acting upon the latter, so as to cause it to project forwards, or outwards, or inwards, and thus produce more or less angular distortion. This is best seen and most frequently observed when the fracture is situated in the upper third of the bone, and the distortion so occasioned has been attributed to the action of the psoas and iliacus muscles drawing the upper fragment forwards; but that this is not the cause may be easily proved by an examination of the numerous specimens of this fracture in our London museums.

From these it will be seen that the displacement of the upper fragment may be in any direction; outwards, inwards, forwards, or backwards, which could not be the case were its position solely dependent on the action of its own muscles. This is important as respects the treatment of fracture of the femur in its upper third, and the more so because our great authority, Sir Astley Cooper, has omitted all mention of any other distortion than of the upper fragment forwards and upwards, which he attributes to the action of the psoas and iliacus muscles, assisted by the pectineus; and "to prevent this horrid distortion two circumstances," he says, "ought to be strictly observed: the one is, to elevate the knee very much over the double inclined plane; and the other, to place the patient in a sitting position, supporting him by pillows during the process of union."* Now the predominant direction of the displacement of the upper fragment is not directly forwards, but outwards and forwards; and the specimen of this fracture which Sir Astley has had figured in his work is an example of the displacement of this fragment directly outwards, a position which has evidently been brought about by the action of the lower fragment upon it; the latter is at the same time rotated one fourth of a circle outwards, so as to bring its anterior surface to correspond with the external surface of the upper fragment; and hence the apparent projection of the latter forwards and upwards.

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* Op. cit. p. 191.

Combined with the displacements in the axis of the limb, or at right angles with it, are those by rotation: in a large number of our museum specimens, one or both fragments are seen to have undergone some rotation on their axis; but, in the absence of any history with the greater number of them, it is impossible to say whether such rotation was of the upper fragment, or of the lower, or of both; or how much of it might be due to direct muscular action, and how much to mechanical causes.

Symptoms and diagnosis. The usual symptoms of a fracture of the shaft of the femur are, shortening and deformity of the thigh, which is generally unnaturally curved, with the convexity forwards and outwards; eversion, and loss of power of the limb; pain, and abnormal mobility at the seat of fracture; and crepitus on rotation. The nature of the injury is so very apparent, that it cannot easily be mistaken for any other; but the determination of the direction of the fracture, whether transverse or oblique, is by no means easy, and not always possible. If the fracture be in a young child, if it have happened from direct violence, if it be situated near the centre of the shaft, and if the shortening of the limb be inconsiderable, the fracture is assumed to be transverse in direction; but a nearer approach to accuracy may be arrived at by attending to the circumstances under which crepitus may be elicited: if this phenomenon can be evoked in a shortened limb, without previous extension, it is presumptive evidence that the fracture is oblique; if, on the contrary, the limb be shortened, and rotation produce no crepitus till it has been restored by extension to its normal length, we may reasonably presume that the fracture is a transverse one.

Prognosis. The prognosis of a fracture of the shaft of the femur must depend on its nature, the mode of its production, and the age of the patient. If the fracture be compound, or complicated with the wound of a large vessel, or extend into the knee-joint, the prognosis must be guarded, though not absolutely unfavourable. If it occur in an old person, and from great violence, as from a railway-carriage passing over the limb, or if it be compound and communicate with the knee-joint, the case is one of the greatest danger, and the prognosis will be most unfavourable. On the contrary, a simple fracture of the shaft, if properly managed, and uncomplicated with any other injury or disease, will nearly always do well; and though some shortening of the limb usually results, it is insufficient to impair its usefulness, or to cause more than a slight lameness; a favourable prognosis may therefore be given.

Treatment. Much contrariety of opinion prevails respecting the possibility of curing a fracture of the femur, in the adult, without shortening; and from the time of Hippocrates to the present day, the profession has been ranged in two opposite camps,—one side declaring that shortening of the limb may be prevented, and the other as positively denying it. To determine this question, and without bias either on one side or the other, the writer employed some of his leisure hours in the summer of 1857 in examining all the fractured thighs then under treatment in the different hospitals of this metropolis, till he had procured nearly the same number of cases of this accident from each. To insure accuracy, each limb was measured by a graduated tape from the anterior superior spinous process of the ilium,—1st, to the lower border of the patella; 2dly, to the extremity of the outer malleolus; and 3dly, to that of the inner; and the result was written down on the spot. The total number of patients thus examined was 50, of whom 41 were males, and 9 were females. Their ages varied from 84 to 2 years; 30 being adults, and 20 children under 15 years of age. Now of the total number, only 15 escaped deformity, and of these 12 were children, leaving, therefore, but 3 adults out of 30 in whom no shortening had taken place, and showing that under the present mode of treating these fractures in the London hospitals, shortening of the limb follows in 90 per cent of the adults admitted, and in 40 per cent of the children. Even this high percentage is probably underrated as regards adults; for, in truth, 2 of the latter in whom no shortening was found were recent admissions, the accident having happened but two days previously in the one case, and four days in the other, rendering it therefore doubtful what the ultimate issue might be: even the single case in which there was no shortening is not free from suspicion, for although the accident had occurred five weeks before, the long splint was still on, and in the absence of examination without it, one could not be sure that the limb had been fractured. The writer's individual experience at the Westminster Hospital is entirely confirmatory of the above results obtained at all the other hospitals; and with the full knowledge of this tendency to shortening in fractures of the femur, and with every attempt to prevent it, he has not yet succeeded in a single case in the adult, nor has he found, in upwards of 100 specimens of this fracture which he has examined in the various museums of the metropolis, more than one in which there was not some shortening. With reference to the amount of shortening in the 35 cases out of the 50 already mentioned it was,

½	an inch	in	4	1¼ to 1½	inches	in	4
⅔	,,	,,	2	2	,,	,,	3
¾	,,	,,	10	2½	,,	,,	1
1	,,	,,	9	3⅓	,,	,,	1

and in one it was not ascertained, both thighs being broken.

These results of the writer's own observations are fully confirmed by Malgaigne and Hamilton; the former of whom bears this strong testimony on the subject: "There has been too much discrepancy of opinion among Surgeons in regard to this (shortening). Hippocrates gives the idea that the shortening can always be obviated; Celsus goes to the opposite extreme, declaring that a thigh once broken must ever remain shorter than its fellow. At a period by no means remote from our own, Desault claimed to cure all fractures without shortening, and his Journal contains several such cases. In imitation of him, many Surgeons have varied, corrected, and improved apparatuses for permanent extension, and have announced as complete successes from them. I must, however, state positively that I have never obtained any thing of the kind, either with contrivances of my own, or with those of others, or even when I have invited the inventors of such apparatuses to apply them in my wards. I have more than once examined persons said to be cured without any shortening, but always discovered such shortening by careful measurement. The mistake of all those who have thought they had obtained these miraculous cures was, that they never dreamed of comparing the two limbs in regard to their length; I will say, moreover, that they were most commonly ignorant of the proper way to obtain a good and correct measurement. Some have been deceived in another way; they have lighted upon fractures with interlocking, especially in young subjects, and have imagined that they had corrected by treatment a shortening which never existed. In short, when the fragments remain in contact, or when we can replace them and keep them so by means of their serrations, it is easy to cure a fracture of the femur without shortening; in the absence of these two conditions the thing is simply impossible."*

Hamilton also states, that "in case of an oblique fracture of the shaft of the femur occurring to an adult, whose muscles are not paralysed, but which offer the ordinary resistance to extension, and counter-extension, and where the ends of the bone have once been completely displaced, no means have yet been devised by which an overlapping and consequent shortening of the end of the broken bone can be prevented." He also affirms that "the average shortening in simple fractures, where the best appliances and the utmost skill have been employed, is about three-fourths of an inch."*

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* Op. cit. p. 723.

The causes of these different results in the adult and in the child probably depend on the different chemical composition of the bones at these two periods of life, and the modifying influence which this exerts on the form and completeness of the fracture. That the muscles play but a secondary part in this result, is proved by the want of correspondence between the muscular power and the degree of shortening. A healthy boy of 12 or 13 has greater muscular power than a feeble woman of 60 ; yet the former may recover from a fracture of his femur without shortening, the latter will not.

There are three principal modes of treating these fractures: 1st, by permanent extension with the limb in the straight position ; 2dly, by permanent extension with the limb in the bent position ; 3dly, by plasters and bandages, by short splints, or by some of the forms of the immovable apparatus,—these act simply as retentive media, without exercising traction on the limb, which may be either flexed or extended.

First method. To secure permanent extension in the straight position, traction is made on the limb by means of a long outside splint, to the lower end of which the foot is fixed, while to the upper, which should reach nearly as high as the axilla, are attached the ends of a perineal bandage ; by tightening the latter, the splint, together with the limb below the fracture, is thrust downwards, and permanent extension is thus provided for. A splint of this kind, having near its upper end two holes, and near its lower end a larger opening to correspond with the outer malleolus, and two deep notches at its extremity, was strongly recommended by the late Mr. Liston, and goes by his name ; it is in general use in this country, and has superseded the more complex mechanical contrivances for making extension and counter-extension which were formerly employed. The mode of application is as follows : The patient lying on his back on a firm flat mattress, a few turns of a roller should be first carried round the foot and ankle ; then the splint, well padded on its inner side and reaching from a point opposite the nipple to four or five inches beyond the foot, must be laid on the outside of the fractured limb, and firmly secured to the latter by several more turns of the same roller around the foot and ankle and splint, and through the notches at its lower extremity ; it may then be carried upwards as high as the knee. At this stage of the proceeding traction should be steadily made on the limb by assistants, till its length equals, or even slightly exceeds, its fellow, as ascertained by measuring with a tape from the anterior superior spinous process of the ilium to the lower border of the patella. When this has been effected, the perineal bandage must be applied, its padded centre resting on the perinæum, and its two ends passed through the holes in the upper part of the splint and tied on its outside. By this means the splint is prevented from ascending, and, by tightening the perineal bandage, it can even be forced downwards, and powerful traction thus exerted on the limb. Lastly, the remainder of the limb should be encircled by the roller, and the upper part of the splint bound to the trunk by a few turns of a broad rib-bandage. This method of treating fractures of the thigh, though so generally adopted, is not free from several grave defects. In the first place, it is extremely difficult to keep up even moderate extension without causing ulceration, and sometimes even sloughing of the skin in the neighbourhood of the ankle and perinæum; or if these evils are avoided, prolonged œdema of the limb is not unfrequently caused by the pressure of the perineal bandage on the veins of the upper part of the thigh. On the other hand, if the bandages are applied so loosely as to exert no traction on the limb, or should it become necessary to remove them on account of any of the above evils having arisen, retraction of the limb and considerable ultimate shortening are almost sure to result. Another, though a minor defect of this method of treatment is the impediment which it offers to defæcation, and the unavoidable disturbance of the apparatus during this act. To remedy these inconveniences the following modifications are recommended. 1st, the lower end of the splint, instead of being doubly forked, should be provided with a foot-piece at right angles with the leg-piece, while to its upper end should be fixed an upright crutch, also at right angles with it. 2dly, the foot should be secured to the foot-piece by broad straps of sticking-plaster applied longitudinally to the limb, and extending from just below the knee to nine or ten inches beyond the foot. To render them more secure, a few cross strips may be made to encircle the limb, and a bandage should be applied over them from the foot to the knee, soft pads being interposed opposite the malleoli: the projecting ends of these plaster bands are then to be crossed behind the foot-piece of the splint, and brought over the instep in front. 3dly, the perineal bandage should have let into some part of it a short piece of vulcanised india-rubber; this, while it secures moderate extension, at the same time provides for its being continuous, and not intermittent, as is so frequently the case with the ordinary bandage. 4thly, this bandage should be borne off from the front of the thigh by having its front end fastened to the upright crutch at the upper extremity of the splint. Lastly, the disturbance of the apparatus during defæcation should be avoided by placing the patient on a Luke's bedstead. The use of plaster bands for extension is an American invention, for which there are several claimants, though Dr. Josias Crosby, of New Hampshire, is generally credited with the improvement. The elastic perineal bandage was first used by the writer in 1857, from having observed the difficulty of keeping up traction by the ordinary bandage, which, when first applied, causes pain by its tightness, but afterwards becomes so loose as to exercise no tractive force whatever. Under any circumstances, it is necessary to look to this bandage daily for the first three weeks, to see that it is tight enough to insure extension, but not so tight as to cause pain. It is well also that it should be changed once or more during the treatment; and this opportunity should be embraced for washing the perinæum with a strong solution of alum or zinc, and afterwards rubbing in a little zinc ointment.

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* Hamilton *on Fractures and Dislocations*, p. 414.

Second method. For permanent extension with the limb in the flexed position, a fracture-bed is the most efficient contrivance, and one of the best for this purpose is that of Mr. Amesbury. It "consists of a horizontal frame supporting three pieces of wood or planes hinged together, and long enough, when connected, for an adult to lie stretched out upon them. The upper plane receiving the trunk is raised at the bolster-end; the middle one, intended for the thighs, is made of two pieces, sliding on one another, so as to suit limbs of different lengths, and forms with the third piece a double inclined plane; this last, which supports the legs, has a foot-piece, used to confine the feet when this is necessary, and always serving to sustain the weight of the bed-clothes. The upper of these planes is supplied with a thick mattress, the two others with similar ones only half as thick. The middle one has an opening with a basin fitted to it to receive the fæcal evacuations; and the pelvis is fixed by means of a belt passing across the upper of the three planes. Lastly, the hinges are movable, so that the different angles may be changed at will."*

In the above-described bedstead, extension of the limb is first effected, and afterwards maintained, by leverage, the leg becoming a lever of the first order, the fulcrum being at the hinge, between the second and third planes. It would seem at first sight that, both feet being secured to the foot-piece of the bedstead, and the weight of the trunk serving as a counter-extending force, shortening of the limb could not possibly happen; but experience proves the contrary. In truth, although the trunk rests in the hollow, between the first and second planes, its weight is not supported equally on both buttocks; the patient lies somewhat awry, nearly his whole weight being supported on the sound side, while the pelvis on the side of the injury rises slightly up the second plane of the bedstead, and so approximates the hip to the knee-joint. To keep the pelvis level, the leather band in the above apparatus is insufficient, and in its place should be substituted an iron bar or brace, or two clamps, to embrace the spines of the ilia. This bedstead is not intended to supersede the employment of lateral splints to the thigh; these should extend from the trochanter to the knee on the outer side, and from the perinæum to the same point on the inner, and be firmly secured by straps and buckles, or by a few strips of bandage tied with a slip-knot.

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* Amesbury, *Observations on Nature and Treatment of Fractures*, p. 132.

Third method. This plan of treatment is specially adapted for two classes of cases: viz. infants and young children; and adults who have been treated for the first six weeks by one of the other methods. In the former, it is seldom necessary to do more than encircle the thigh from the knee to the hip with the ordinary diachylon, or the soap-plaster spread upon leather, care being taken that it is not applied too tightly, and that the skin in the perinæum and its neighbourhood is kept dry and clean by changing the napkins the moment they become soiled, and washing the parts from time to time with a solution of alum: a little lapis powder dusted on the parts, or zinc ointment rubbed in, is an excellent preservative against inflammation and excoriation. In older children, splints of leather or gutta-percha may be moulded on the thigh, or some of the forms of immovable apparatus applied,—these are made either with gum, starch, dextrine, albumen, or plaster; and are recommended by some Surgeons for the treatment of even recent fractures in the adult. Thus Mr. Erichsen informs us that he has treated many fractured thighs in this manner, both in adults and children, without confining them to bed for more than three or four days. He gives the following directions for the application of the starch apparatus: "A dry roller should be applied to the whole of the limb evenly and neatly, which must then be covered with a thick layer of wadding; a long piece of strong pasteboard, about four inches wide, soaked in starch, must next be applied to the posterior part of the limb, from the nates to the heel. If the patient is very muscular, and the thigh large, this must be strengthened, especially at the upper part, by having slips of bandage pasted upon it. Two narrower strips of pasteboard are now placed along either side of the limb, from the hip to the ankle, and another shorter piece on the forepart of the thigh. A double layer of starched bandage should now be applied over the whole, with a strong and well-starched spica. It should be cut up and trimmed on the second or third day, and then re-applied in the usual way. The points to be specially attended to are, that the back pasteboard splint be very strong, at the upper part especially, and that the spica be well and firmly applied."*

The chief advantage claimed for the immovable apparatus is the non-confinement of the patient to bed for more than three or four days. Its disadvantages are, the unavoidable handling and movements of the limb during its application, and the impossibility of keeping up extension until it is solidified. Whatever plan of treatment may be selected for these fractures, it is essential to bear in mind that the amount of shortening is, to a great extent, within the control of the Surgeon; and though he may fail to prevent it altogether, he may greatly diminish it by care and frequent supervision. As respects the duration of the treatment for a simple fracture of the thigh, it will average from two to three months in an adult, and from six weeks to two months in a child. It is by no means necessary that patients should remain in bed all this time; six weeks will generally be long enough for an adult, and four weeks for a child; after which the immovable apparatus should be applied, and they may be allowed to go about on crutches; but they will seldom be able to dispense with all support to the limb under the period mentioned above.

In reference to the treatment of a compound fracture of the femur, unless the bone be much comminuted, or the soft parts much bruised or lacerated, or the principal blood-vessels wounded, or the knee-joint opened, it may be treated as a simple fracture, substituting only a splint, which is interrupted at the seat of the injury for an ordinary one. The above complications, however, will in most cases call for amputation.

Fractures into the knee-joint. These may involve each or all of the bones entering into the formation of the joint, and the gravity of the accident will be in direct relation to the number of the bones implicated, their degree of comminution, and whether the fracture be simple or compound. Fractures of the femoral part of the joint may be situated either above the condyles or through them; and may be transverse, oblique, or vertical. Not unfrequently they are multiple, the two condyles being detached from the shaft by a transverse fracture, and from each other by a vertical or oblique fracture. The latter also may traverse either condyle, or the intercondyloid space. None of these varieties are necessarily attended with displacement of the fragments, though its absence is an exception to the rule. In young children the epiphysis is sometimes separated from the shaft, and chips of bone are sometimes detached from the condyles into the joint, where they act as foreign bodies, and occasion much inconvenience to the patient. Fractures of the head of the tibia are more rare, and, unless compound, they are not usually dangerous; nevertheless, lameness not unfrequently results from the inflammation which these fractures set up in the knee-joint, and the permanent stiffness which follows.

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* Erichsen, *Science and Art of Surgery*, 2d ed. p. 218.

These injuries are sometimes caused by getting the leg between the spokes of a wheel in motion, by falls on the knee, or by kicks. The nature of the accident is recognised by the mobility of the fragments, the crepitus, the swelling of the joint, and the impossibility of bearing any weight on the limb.

The treatment consists in placing the limb, very slightly flexed, on a Macintyre's splint for thirty-five or forty days, when passive motion should be commenced to prevent ankylosis. If much inflammation arise, it may be reduced by leeches, fomentations, poultices, or evaporating lotions, as most agreeable to the patient's feelings. In compound fractures into the joint, amputation of the limb will generally be necessary.

Fractures of the Patella.

Fractures of the patella present the same varieties as fractures of other bones; they may be simple, comminuted, or compound, vertical, oblique, or transverse; and are caused either by direct violence, as falls or blows upon the knee, or by muscular action. Of all the bones of the skeleton, the patella is most liable to be broken from the latter cause; and the frequency of its occurrence would imply some peculiarity in the structure or position of this bone. As regards structure, Malgaigne affirms that these fractures are sometimes favoured by an antecedent morbid condition of the bone; but this will not explain their greater relative frequency as regards the other bones of the skeleton, unless it can be shown that the patella is more prone to this morbid change than they are. As respects position, when the knee is slightly bent, the patella is supported upon the condyles of the femur on its transverse axis only, whilst its upper half is unsupported behind, and its superior edge projects slightly upwards. Under these circumstances, a sudden and violent contraction of the extensor muscles of the leg, which are now nearly at right angles with the vertical axis of the patella, may snap the bone in two, as not unfrequently happens when a violent effort is made to prevent oneself falling backwards, or in voluntarily throwing oneself backwards to avoid falling forwards. Fractures of the patella by muscular action are always transverse, or nearly so, and generally take place through the centre of the bone, though they may be above or below it. The frequency of fractures in this direction seems to have led English Surgeons to the belief that the majority of fractures of this bone are of muscular origin. This is contrary to the experience of foreign Surgeons, who attribute the greatest number of these fractures to direct violence: thus, of nine cases related by Boyer, five were caused by falls on the knee, which accident likewise produced eleven of the nineteen fractures observed by Malgaigne; while of fourteen which came under the observation of Hamilton, thirteen were the result of direct blows or of falls on the knee, and only one was due solely to muscular action. The extent to which the fragments may become separated in transverse fractures of the patella, is subject to considerable variation, and depends chiefly on the mode in which the accident happened. In a fracture from a blow, the patient may not fall down at all; in one from a fall on the knee, he falls forwards or sideways; but in a fracture from muscular action, he falls backwards, with the leg under the thigh. In the two former instances there may be little or no laceration of the fibrous structures attached to the patella, the fragments of which may be only slightly separated; but in the latter, owing to the sudden and violent contraction of the quadriceps, and the forcible flexure of the knee in falling, the soft parts will be more extensively lacerated, and the separation of the fragments correspondingly great.

Symptoms and diagnosis. The symptoms of fracture of the patella are generally well marked; when transverse, the separation of the fragments leaves a depression in front of the joint, into which the fingers may be inserted, and the condyles of the femur readily felt. Above and below this depression, the fragments of the patella may be recognised, and, on bending the knee, the interval between them will be greatly increased. The power of extending the limb, or of bearing any weight upon it, is lost or impaired. In vertical and comminuted fractures of this bone, the fragments can be easily brought into juxtaposition, and crepitus elicited. All the varieties of this fracture are followed by more or less inflammation in the knee-joint, which not unfrequently becomes greatly distended with fluid, and thus separates still further the broken portions of bone.

Pathology. It is rare for a broken patella to become united by bone, especially when the direction of the fracture is transverse; more frequently the fragments are united by a ligamentous tissue, which varies in length from half an inch to an inch and a half. Most frequently, however, according to Mr. William Adams, to whom we are indebted for these observations, the fragments remain ununited, and are connected with each other merely by a portion of the fibrous capsule of the knee-joint, thickened, and having incorporated with it the bursa naturally existing on the front of the patella; in this case the fragments may be separated to the extent of four or five inches. Of thirty-one specimens examined by Mr. Adams, fifteen were examples of ununited fracture, twelve of true ligamentous union, and four were doubtful from their being dried.* The number of the above specimens is obviously too small to warrant us in asserting that, when the space between the fragments exceeds an inch and a half, there has never been true ligamentous union, and that the case must be regarded as one of ununited fracture.

Most Surgeons must have met with cases in which good ligamentous union had taken place, the fragments not being more than one-half to three-quarters of an inch apart; yet, after the patient had been going about for a few weeks or months, there has been found a wide interval between them, owing to the gradual yielding or the sudden rupture of the new material. This appears to be demonstrated by a preparation in the museum of the Westminster Hospital. The fragments of a broken patella are separated to the extent of two inches and a half, and are connected with each other, on their outer surfaces, by a portion of the fibrous capsule of the knee-joint, on their inner, by the synovial membrane of the joint, and intermediately by true ligamentous tissue; this is thick at its attached extremities, but gradually becomes thinner towards its centre. Hamilton examined a patient who had had his patella fractured nine weeks before, and found the fragments united by a short ligament, except on the inner side, where there was a separation or rupture of the ligament to the extent of a quarter of an inch. The patient explained this by saying that the splint was removed at the end of four weeks, and that, after a week more, he began to walk, but that he almost immediately felt it tear or give way on the inner side. Dr. Coale also presented to the Boston Society for Medical Improvement "a specimen of a fractured patella taken from a man sixty-five years old, the fracture having occurred ten years before. The fragments were at first so closely united that no division between them could be discovered; but subsequently they became separated at their outer edges one inch, and at their inner edges one-eighth of an inch."* The great rareness of bony union in transverse fractures of the patella is owing simply to the difficulty of keeping the fragments in sufficiently close apposition; when this is accomplished, bony union occurs as in other fractures.

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* *Transactions of the Pathological Society of London*, 1849-50, p. 258.

Treatment. Three different plans have been adopted in this fracture; one consists in relying simply on the position of the limb, another in the immediate application of apparatus for bringing together the fragments, and a third in trusting to position only for the first ten or fourteen days, and then applying some approximative apparatus for the remainder of the period. The chief objection to the first plan is, that it is only applicable to those few cases in which there is but little or no separation of the fragments. In the majority of transverse fractures the fragments are more or less separated, and cannot be brought into contact with each other by mere position; so that the only question for consideration is, whether the apparatus for adjustment should be applied immediately or deferred till all inflammation and effusion into the joint have disappeared. The strongest argument in favour of immediate adjustment is derived from the fact that the extensor muscles go on contracting for some days after the fracture; so that not only is the upper fragment still further separated from the lower, but the muscles become so shortened that the fragments cannot be brought into contact with each other after the inflammation has subsided. On the other hand, if the inflammation in the joint is severe, the usual appliances for forcibly approximating the fragments would be injurious, and some delay seems absolutely necessary. The difficulty may be overcome by keeping the limb extended on a back-splint, flexing the thigh and trunk on each other so as thoroughly to relax the rectus, and then acting on the fragments longitudinally or in the axis of the limb, instead of circularly and nearly at right angles with it. Perhaps the simplest plan to effect this is that of Dr. Sanborn, of Lowell, U.S., who fixes a long strip of sticking-plaster, two inches and a half wide, in front of the limb, from the upper portion of the thigh to the middle of the leg, leaving at the knee a free loop. A bandage being applied above and below the knee, for the purpose of securing the plaster and controlling the circulation and muscular contraction, a small stick, six or eight inches in length, is put through the loop over the knee, and the plaster twisted until the fragments of the patella are brought into apposition.* The late Mr. Lonsdale invented an ingenious instrument for bringing together the fragments, without making circular constriction of the limb. It consists of two plates of metal, shaped something like a horse-shoe, so as to grasp the upper and lower portions of bone; they are also slightly concave underneath, to fit the shape of the limb on which they press. These two plates are fixed on two iron rods, which slide forwards and backwards on two horizontal bars, which are again made to slide up and down two strong vertical rods placed on either side of the knee, and fastened to a back-splint: thus both vertical and horizontal movements are provided for; by the former the plates gain their hold on the edge of the bone, and by the latter the two portions of bone are approximated; thus all circular constriction of the limb is avoided, and local applications to the inflamed joint are not interfered with.† Malgaigne has also devised a small instrument which he considers superior to any hitherto employed; but it can only be applied after all swelling of the joint has subsided, and it moreover labours under the disadvantage of being both difficult and painful of application; it is also liable to produce a tilting backwards of the fractured borders of the patella, which will thus be in contact only by their anterior margins. It consists of "two steel plates, each an inch long and two-thirds of an inch wide, sliding upon one another, and this sliding regulated by a screw. The free extremity of each is bifurcated, and recurved into two very sharp hooks. The two hooks of the lower plate, only one-third of an inch apart, are intended to be inserted at the apex of the patella, which is lodged between them; those of the upper plate, which are to catch on the base of the bone, may be separated by a space twice as wide; and the inner one should also be longer than the outer by one-sixth to one-fifth of an inch, to make up for the obliquity of this end of the bone."‡ The action of this instrument is evident.

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* Coale, *Boston Med. and Surg. Journal*, vol. liv. p. 402.

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* Hamilton *on Fractures and Dislocations*, p. 443.

† Lonsdale *on Fractures*, p. 427.

‡ Malgaigne, op. cit. p. 779.

None of these plans have hitherto been much used in this country; but Surgeons have contented themselves with fixing the limb in the extended position, and then applying a figure-of-eight bandage, so as to include within its loops and draw towards each other the two fragments. Or the same end has been attempted by circular belts of leather, fastened above and below the patella, and then made to approximate by longitudinal straps. An improvement on these are the modifications of Wood and of Hamilton, which consist, essentially, in fixing the retentive bandages or plasters to a broad back-splint, instead of around the limb; by this means the patella is grasped only on its front and sides, while a free space is left between the limb and the splint for the circulation to go on uninterruptedly. The chief defect of all these contrivances is their tendency to tilt forwards the fractured edges of the patella, causing them to gape in front, and so counteracting the intention for which they were applied; with a little mechanical skill, however, this may generally be overcome, and good ligamentous, if not bony, union obtained.

The average period for which retentive apparatus should be applied is from thirty-five to forty days; if it be removed earlier, or if the patient go about too soon, or if the fragments have not been properly adjusted in the first instance, the intervening ligament will be long and weak, or union may be wanting altogether. On the contrary, a too prolonged confinement of the limb is apt to terminate in permanent stiffness. It is pretty generally admitted, that the shorter the connecting medium between the fragments, the stronger and the more useful will be the limb; but the degree of restoration of which this is capable, in cases of non-union, or of an elongated uniting ligament, is a point on which there is much difference of opinion. The writer's experience leads him to regard complete restoration as exceedingly rare, and the general insecurity under which the subjects of such accidents labour is proved by the frequency with which they fracture their other patella; so that it may be safely affirmed, that a person who has had the misfortune to fracture one patella becomes thenceforth prone to a repetition of the accident in his opposite limb. For these reasons it is advisable to wear a knee-cap, or some other apparatus, which shall support, and, at the same time, limit the movements of the knee-joint.

The treatment of vertical and oblique fractures of the patella does not differ materially from that required for transverse fractures of the bone. The limb must be placed in the extended position on a Macintyre's splint, and, when the inflammation has subsided, the fragments must be brought together by firm pads, applied on each side of the bone, and fixed there by straps and bandage.

Fractures of the Leg.

Although each of the bones of the leg may be fractured separately, it is most common to find both broken; and the above term is usually restricted to this injury. The reason of the greater frequency of fracture of both bones, than of either bone singly, is probably owing, as Mr. Lonsdale has suggested, to the fact that a force sufficient to break the tibia is generally sufficient to extend to the fibula afterwards, and so to break it; whereas it must be a peculiar kind of force to break either the tibia or fibula singly.

Of 289 fractures of the leg admitted into the Middlesex Hospital between the years 1831 and 1837, 197 were of both bones, 51 of the fibula, and 41 of the tibia.* The extreme rareness of these fractures in infancy and childhood is a remarkable fact, especially when contrasted with the great frequency of fractures of the femur at this period, and the still greater frequency with which they themselves occur in after-life.

Of 515 cases collected by Malgaigne, but one was as young as four years, and only 12 were met with between five and fifteen years of age.

The causes of fracture of the leg are either direct, as the passage of a wheel over the limb; or indirect, as in slipping down or jumping from a height. The relative frequency of these causes in the production of this fracture has been variously estimated by different writers. Hamilton considers that four-fifths of them are caused by direct violence. The writer's experience is more in accordance with that of Malgaigne, who in 67 fractures of the leg, found 36 produced by direct violence, and 31 by indirect.

The most frequent situation of fracture of the leg is where, from the greater weakness of the tibia, one would expect to find it, viz. in the lower third; so that of 142 fractures, from all causes, recorded by Hamilton, 85 occurred in this situation, 40 in the middle third, and only 11 in the upper third. The fibula is rarely broken at the same level as the tibia, but at a variable distance above it; most frequently, according to Lonsdale, from two to three inches above it. Fractures of the leg present every variety of this injury which is met with elsewhere; but, from the superficial position of the tibia, comminuted and compound fractures are more common here than in any other part of the body.

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* Lonsdale, op. cit. p. 19.

In the neighbourhood of the knee- and ankle-joints, owing to the great force which is required to break the bones, these forms of fracture prevail; it has also been observed that the direction of the fracture in these situations is prone to be vertical, and so to implicate those joints. The prevailing direction of simple fractures of the leg is oblique, with the obliquity downwards and inwards, and generally slightly forwards; less frequently it is downwards and outwards, and still more rarely downwards and backwards.

Displacements of the broken bones may take place in these as in other fractures, and from the same causes; not unfrequently, however, there is no displacement, as in some transverse fractures; and it may be stated generally, that the more nearly the fracture approaches a transverse direction, and the nearer it is situated to the upper end of the bone, the less will be the liability to displacement, and the less its amount should it occur; indeed, in transverse fractures of the tibia, although the fragments may form an angle with each other, or the lower fragment be rotated outwards or inwards, they rarely become completely disengaged. In oblique fractures, on the contrary, there is nearly always overlapping, sometimes to a considerable extent, as when the fracture is caused by a fall on the feet from a height; for here the force being more than sufficient to break the bones, continues to act, and so displaces them. Should, however, the whole of the force be expended in causing the fracture, the subsequent displacement of the fragments is usually not great, and affects almost exclusively the lower fragment, which is drawn upwards, generally behind the other, but having an inclination to the inner or outer side, according to the direction of the line of fracture which regulates it; thus, the prevailing direction of the oblique fracture being downwards, inwards, and forwards, the displacement will be upwards, outwards, and backwards. Combined with this, there is often some rotatory displacement of this fragment outwards, due probably to the weight of the foot, and its tendency to gravitate in this direction. Accordingly in 19 specimens of united fracture of the bones of the leg, examined by Mr. Shaw, 16 had the lower fragment rotated outwardly, and situated somewhat to the outer side, and behind the upper.*

Symptoms and diagnosis. There is rarely much difficulty in detecting a fracture of the leg, the superficial position of the tibia rendering any deviation from its normal form and direction evident. In those cases, however, in which the fragments remain *in situ*, or in which there is much swelling, the nature of the injury may be overlooked; but the history of the accident, the sensations of the patient, his inability to support himself on the fractured limb, the mobility at the seat of fracture, which may be rendered evident by grasping the limb at some distance above and below the fracture, and then endeavouring to bend it between these two points, and the crepitus on rotation cannot fail to demonstrate the true nature of the injury. When the fracture is situated just above the ankle-joint, it is very liable to be followed by considerable displacement, so that the accident closely resembles a dislocation of the foot: from this, however, it may be distinguished by the signs pointed out under that head. But although the fracture of the tibia may generally be easily recognised, it is not always easy to discover whether the fibula also is broken, especially if the fracture be at some distance from that of the tibia. By making firm pressure along the bone, a depression may sometimes be felt at the seat of the fracture, or the two broken extremities of the bone may be pressed inwards towards the tibia. There are two symptoms not uncommon in fractures of the leg, though rare in most other fractures, viz. startings of the limb, and vesication of the skin in the neighbourhood of the fracture; large bullæ, containing a bloody serum, not unfrequently form within the first forty-eight hours of the injury, and if the skin in the neighbourhood is at the same time ecchymosed, the appearances may be mistaken for gangrene. They are of no importance, and require no treatment beyond puncturing them to let out the fluid.

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* *Path. Soc. Trans.* 1848-9, p. 125.

Treatment. Perhaps there are no fractures more easy or more difficult to treat than those of the leg; a starch bandage, or laying the limb on a pillow, being all that is necessary in some cases; while the utmost ingenuity and the most constant supervision are required in others. Reduction of the fragments, when displaced, is to be accomplished by bending the thigh, leg, and foot at right angles with each other, and then making extension and counter-extension from the knee and ankle. In compound fracture, where the upper fragment projects through the skin, it is sometimes impossible to reduce it without enlarging the wound; in other cases, division of the tendo Achillis will facilitate the reduction, as well as the subsequent retention, of the fragments; while in others it may be most expedient to saw off, or otherwise remove, the projecting portions of bone. To retain the fragments in their place after reduction, various contrivances are employed, some of which are adapted for one kind of fracture, and some for another. Occasionally there is so little tendency to displacement that the patient may lie on his back, with his limb extended on a pillow, reaching from a little above the knee to beyond the heel, and supported on each side by junks, or by flat splints rolled up in a piece of sheeting, placed between the leg and the pillow, till they reach the leg, against which they must be firmly secured by three or four broad straps or bandages; thus the foot, ankle, and knee are firmly supported in a line with each other. Where more efficient means of confinement of the limb are necessary, splints with a foot-piece, as Macintyre's or Liston's, which provide against both lateral and antero-posterior displacement of the fragments, may be substituted. The only defect of these splints is, that they do not effectually provide against the rotation of the upper fragment on the lower, so that if the patient is restless, and inclines his body to either side, the upper fragment is apt to follow its movements. Hamilton is of opinion that Pott's method, slightly modified, is the best, and is applicable to nine-tenths of all simple fractures, and to some compound. By this plan the patient lies on his injured side, with the limb well flexed, and supported between Sharp's splints. In compound fractures, treated in this manner, it is necessary for one of the splints to be interrupted, and an ingenious modification of the ordinary interrupted splint has been recently invented by Dr. Skipton. The essential feature of this splint, which is made of sheet iron, is, that it consists of several pieces, any one or more of which can be removed, so that no matter in what part of the leg the wound may be, the same splint will serve. The chief advantage of Pott's method of treating these fractures is the relaxation it affords to all the most powerful muscles of the limb, and the consequent lessening of the disposition to spasm and displacement; it is generally also, for some time at least, the easiest and most natural position for the patient to lie in, and it admits of a ready examination of the limb without disturbing it, by simply unbuckling the straps and removing the upper splint. To render this method of treating fractures of the leg perfect, the splint should have a second curve, at the upper part of the leg-piece, at right angles with it, and in an opposite direction to the lower, so as to embrace the knee-joint and lower third of the thigh. With such splints, firmly securing the joints above and below the fracture, no displacement or movement of the fragments on each other could possibly happen. But to do away with the irksomeness of long confinement in one position, and to secure the utmost comfort to the patient, the limb should be slung; and for this purpose various kinds of slings have been devised. One of the best and simplest of these is that of Mr. James Salter,* which differs from all others in the great freedom of movement it allows to the patient, without risking the disturbance of the fragments. This is effected by the sling being balanced on a *single* chain, suspended by a swivel-hook from two brass wheels, which run along a steel rail on the top of the protecting cradle. By the former arrangement the patient "can shift his body from one side of the bed to the other, while the foot moves in the opposite direction, the leg moving in the same plane upon the axis of the swivel;" by the latter, he can draw himself up towards the head of the bed, to the extent of eighteen inches, or let himself down again to the same extent,—movements which always ensue on altering one's position from a reclining to a sitting posture, and the contrary. In all the ordinary slings, the limb is suspended by two cords, and thus the movements of the patient are necessarily more restricted; a fracture put up in a Nevill's splint, and slung in this manner, is, however, a very efficient and simple mode of treatment, and is in general use in St. Bartholomew's Hospital. Whatever apparatus the Surgeon may select for the treatment of these fractures, care must be taken that the sufferings of the patient are not increased by any maladroitness in their application, or by any unequal pressure of any part of them, or of the bandages used to secure them. The ball of the great toe should be in a line with the inner border of the patella; and the concavity between the heel and the lower part of the calf should be equal in both limbs. Some Surgeons dilate on the difficulty of keeping down to its proper level the upper fragment, which they consider to be tilted forwards by the extensors of the leg, and Malgaigne has invented a sort of tourniquet, the screw of which is made to press on the projecting bone, and, being very sharp at its point, to penetrate its substance. It is rare that such projections cannot be overcome by position, combined with pressure and counter-pressure.

Fractures of the fibula. Any part of this bone may be broken by direct violence, and the fracture be unaccompanied by displacement or other injury; but most frequently the bone yields to indirect force, at a point from two to four inches above the extremity of the malleolus, and this is accompanied by a partial dislocation of the foot.

The accident is caused either by a sudden twist of the foot outwards or inwards, or by its becoming fixed in a cleft, and the body falling to one or the other side, as in the well-known case of Sir Astley Cooper, who fractured his right fibula by falling on his right side while his foot was entangled between two pieces of ice.

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* *On a new Swinging-Apparatus for the Treatment of Fractures of the Leg.*

As to the relative frequency of the causes which produce the fracture, of 200 cases which came under the observation of Dupuytren, 20 were the result of direct violence, 60 were produced by forcible abduction of the foot, and 120 by forcible adduction. The greater frequency of this injury from indirect violence than from direct is generally admitted; but in the experience of English Surgeons, abduction of the foot is a more frequent cause of this fracture than adduction.

Hamilton, in a record of 32 fractures of the fibula, was able to ascertain the cause satisfactorily in 18. Of these, "3 were the result of falls directly upon the bottom of the foot, 4 of a slip of the foot in walking on level ground, or on ground only slightly irregular; and 12 (query 11) of direct blows. In all of the fractures which have been produced by falls on the bottom of the foot, and in all except one produced by a slip of the foot, the accident was accompanied with a dislocation of the ankle, the foot being turned outwards."* In 7 also of the 11 (?) produced by direct blows, the tibia was thrown more or less inwards and the foot outwards. These 18 cases in which the cause of the fracture is said to have been ascertained, are obviously too few to invalidate the general belief in the greater frequency of indirect than direct fractures of the fibula; neither is it credible that a fall flat on the foot without a subsequent twist of it, or, what amounts to the same thing, an inclination of the body to one side, could fracture this bone. To produce such a result, there must be a change in the direction of the line of transmission of the weight of the body from the tibia to the fibula. In the fracture from eversion, the internal lateral ligament is frequently torn through, and even the inner malleolus fractured; but in the fracture from inversion, the external lateral ligament remains entire, and probably contributes to the fracture, the bone yielding to the pressure of the astragalus against the external malleolus.

Displacement of the foot does not necessarily follow a fracture of the lower third of the bone, even when caused by indirect violence; and Malgaigne affirms, with much positiveness, that in the majority of fractures by adduction there is no displacement whatever, and that when it occurs, it is secondary, and owing to the patient's attempt to walk; when the foot becomes turned outwards, as in the fracture from abduction. Even when produced by the latter cause, he affirms there may be no appreciable displacement.

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* Hamilton, op. cit. p. 453.

Hamilton, on the contrary, as before quoted, found displacement in all but one of his indirect fractures, and in all but three of the direct; while Dupuytren asserts that nine-tenths of his fractures were attended with displacement. It is probable that Dupuytren has as much exaggerated the frequency of the subsequent dislocations as Malgaigne has underrated their frequency. With reference to the obliquity and the position of the fragments, it may be stated, generally, that fractures from indirect violence are usually more or less oblique, and those from direct, transverse; and that when displacement of the foot occurs, as a consequence of the fracture, the broken ends of the bone will project inwards towards or even against the tibia.

Symptoms. A fracture of the fibula, unless attended with displacement of the foot, cannot be recognised by any external sign, for the fragments are kept in apposition by the tibia, and there is, consequently, no deformity; while ecchymosis, if present, may exist independent of fracture. The best means of detecting the fracture is by grasping the leg with both hands, and with the thumbs making alternate pressure on the bone immediately above and below the suspected fracture, when, if it exist, motion and crepitus will at once be felt; or, if the fracture be situated just above the malleolus, the lower fragment may be acted on by forcibly inverting and everting the foot, while the thumb of the other hand is placed over the fracture; the characteristic signs will thus be elicited.

Treatment. For a simple fracture of the fibula in its upper two thirds no treatment besides rest is necessary; but in the lower third of the bone the application of some apparatus is advisable, even should the fragments not be displaced. Nothing is better for this purpose than the starch bandage, strengthened by pasteboard splints on the inner and outer sides of the foot and ankle, care being taken that no displacement occurs during their application, or while the apparatus is drying. In those cases of fracture accompanied with marked displacement of the foot, and therefore rupture of the internal lateral ligament (Pott's fracture), Pott's method is that usually adopted in this country. This consists in placing the patient on his injured side, with the knee bent and the foot somewhat inverted, so as to insure the broken ends of the bone being in contact with each other, and not with the tibia. A Sharp's splint, well padded, and having the pad for the foot-piece thicker than that for the leg, so as to raise a little the outer border of the foot, should next be applied on the outer side of the limb, and, for greater security, an inner splint without a foot-piece may also be placed on the inside of the limb. Dupuytren considered that Pott's method was insufficient to maintain the reduction, and directed the foot to be brought into such a state of adduction as that its inner edge should become superior, its outer edge inferior, and its sole directed inwards. For this purpose he employed a wedge-shaped cushion, the thick end of which was downwards and applied upon the inner malleolus; over this a splint was laid, which reached from the knee to three or four inches beyond the edge of the foot; the leg being then secured to the splint, the foot was next drawn inwards and firmly fixed to the projecting end of the latter. The principle of this method is to make the foot act as a lever on the lower fragment of the fibula, so as to draw it outwards from the tibia, while at the same time the lateral pressure fixes the astragalus firmly against the inner malleolus.

The period for which any apparatus should be kept on will depend on the situation of the fracture, and the injury done to the ankle-joint. In fractures of the upper part of the bone, it has been already stated that no application is necessary; but in the lower part, even should there be no displacement, splints should be kept on for three or four weeks; and in case of a dislocation of the foot, for six weeks or two months. In all fractures of the fibula in its lower third, great caution should be observed in using the limb after the removal of the apparatus, and it may be well to support the joint for some time by a laced boot, strengthened on the inner side; the sole should also be made somewhat thicker on its inner than its outer edge.

Fractures of the tibia. A direct blow on the tibia, as a kick, will sometimes break this bone without the fibula, and the fracture may be situated at any part, or take any direction; it is, however, more commonly met with in the upper than the lower half of the bone, and is more frequently transverse in direction than when accompanied with fracture of the fibula; this circumstance, together with the integrity of the latter bone, renders displacement of the fractured ends almost impossible, and the diagnosis of the injury is thus oftentimes obscure. "In some kind of fractures near to the ankle-joint, when the injury is caused by a fall, and not by a direct blow, there may be displacement, although the fibula remain entire; for the weight of the body will continue the force onwards after the tibia is broken, and so produce a distortion in the position of the foot and ankle-joint, according to the direction in which the force is applied. Thus, in a fracture of the lower end of the tibia, about an inch or an inch and a half above the ankle, that portion of the bone connected with the astragalus will move in whatever direction the foot is forced, and so may be twisted upon the shaft of the bone, or pushed backwards or forwards to a sufficient extent to produce a marked distortion."* When, however, from the absence of all displacement of the fragments, the existence of fracture is doubtful, it may be suspected if pain constantly persists in one part of the bone, if this pain be increased by pressure, and, above all, by bearing any weight on the limb; but to convert suspicion into certainty, the limb should be firmly grasped above and below the suspected fracture, and attempts made to bend it; by its yielding to, or resisting the force applied, we ascertain whether it is broken or otherwise.

Treatment. Of all the fractures of the lower extremity, this is perhaps the best adapted for the immovable apparatus, the application of which, *mutatis mutandis*, may be made in the same way as directed for fractures of the femur.

Fractures of the Foot.

These are most frequently caused by heavy bodies falling upon it or crossing over it, and so crushing it: hence the soft parts also are not unfrequently lacerated, or contused to such an extent as to require the removal of a part, or the whole, of the member; if, on the contrary, the soft parts are not much injured, rest and support, together with evaporating lotions, constitute the only treatment necessary.

The only bones of the tarsus the fractures of which require special notice are the astragalus and os calcis. The fracture of the former, according to Malgaigne, is always caused by a fall from a height, and it is often the only tarsal bone which is broken, while in a general crushing of the tarsal bones it nearly always escapes injury. The direction of the fracture is most various, though most frequently it is through the neck of the bone, and, unless compound, cannot usually be detected; in the latter form of injury, the portion displaced should be returned, or, if completely isolated, removed.

The os calcis may be broken either by crushing, falling from a height on the heel, or by muscular action. Malgaigne considers the latter mode of fracture problematical; he could find only eight cases recorded, and most of them so loosely that they fall far short of proof. In two cases the fracture was said to have been the result of a false step; in one it was caused by the upsetting of a wagon; in five by falling from a height on the feet. The fracture is always situated behind the astragalus, and, we may presume, ought to be vertical in direction; but in the published accounts of this fracture this point is left in uncertainty. The extent to which the detached fragment is drawn up by the gastrocnemius and soleus has been found to vary from almost nothing to five inches; a difference which is probably owing to the part at which the fracture has taken place, and whether the posterior fragment is completely isolated from the rest of the bone, or is partially connected with it by the fibrous structures in the sole. The nature of the injury is easily detected by examination; in addition to the pain, swelling, and deformity, the detached portion can be felt, and its relative distance from the heel will be lessened or increased by extension and flexion of the foot. The treatment consists in subduing the inflammation and keeping the foot extended and the leg flexed, by any of the contrivances made use of in rupture of the tendo Achillis. In fractures by crushing the symptoms are more severe, the pain, swelling, and ecchymosis greater, and the crepitation more obscure; the two most characteristic signs are, increased width of the heel, and lowering of the arch of the foot. This fracture has been mistaken for a sprain, and for a fracture of the fibula without displacement, from either of which it may be distinguished by the above-mentioned symptoms and a careful manual examination. Consolidation takes place slowly, and it is often several months before the functions of the foot and ankle are restored.

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* Lonsdale *on Fractures*, p. 110.

The best method of treatment consists in placing the limb on its outer side, on a Sharp's splint, till all the acute symptoms have subsided, when some of the forms of the immovable apparatus may be substituted, and the patient allowed to go about on crutches. The apparatus should be worn for two months before attempting to use the foot. Fractures of the metatarsal bones and phalanges are always the result of direct violence, and, if simple, require no treatment but rest, and the ordinary remedies to subdue inflammation. If compound, the treatment must be regulated by the number of bones fractured, their degree of comminution or displacement, and the condition of the soft parts; if the latter are not bruised beyond recovery, and if the former can be replaced, and the constitution of the patient is good, an attempt should be made to save the foot. Under opposite circumstances, the injured parts should be removed, care being taken to leave as much of the sound portions as shall insure a useful stump.

DISLOCATIONS.

Dislocations of the Hip.

The head of the thigh-bone, though lodged in a deep cavity to which it is accurately adapted, and in which it is retained by atmospheric pressure, and by strong ligaments and muscles, is yet more frequently displaced than these physical and anatomical dispositions would seem to admit of. Indeed, if reliance is to be placed in the statistics of this accident collected by M. Malgaigne at the Hôtel Dieu, there is no joint of the lower extremity in which dislocation occurs so frequently as in the hip: next to the shoulder, it is the most liable to this accident of any joint in the body, as seen in the following table.*

In 491 cases of dislocation, there were,—of the

Shoulder	321	Thumb	17	Knee	6
Hip	34	Wrist	13	Radius	4
Clavicle	33	Fingers	7	Patella	2
Elbow	26	Jaw	7	Spine	1
Foot	20				

This great proneness to displacement of the shoulder and hip-joints is doubtless owing, in part, to their extensive range of motion, and, in part, to the powerful leverage which may be exerted on them by a force applied to the distal extremities of the respective limbs, or of the humerus and femur. Dislocations of the hip are nearly always accidental, and result from the application of great force; hence, we should expect to meet with them most frequently in the male sex, and at the most active period of life; this is fully borne out by the accompanying table from Malgaigne. In fifty-one cases of dislocation of the hip, forty-two were males and nine females; and the following were the ages of the sufferers:

At 3 years of age	1	From 45 to 60	10
From 15 to 20	8	„ 60 to 85	5†
„ 20 to 45	27		

In the fifty-six cases of this accident collected by Sir A. Cooper, the age of the patient is not stated in eleven; but in the remaining forty-five, I find seven were under twenty years of age, seven were fifty and upwards, and thirty-one between twenty and fifty.‡ The earliest recorded age at which a dislocation of the hip has occurred is eighteen months, and the oldest, eighty-six years; the former on the authority of Lisfranc, and the latter of Gauthier. In this country, the youngest I can find on record was three years and a half; the case is reported by Mr. Image in the *Provincial Medical and Surgical Transactions*, vol. xii. p. 386. Although dislocations of the hip cannot usually happen without the application of great force, individuals have been met with who possessed the power of voluntarily dislocating their hip, and again reducing it, as related by Sir A. Cooper in his work on *Dislocations and Fractures* (case 2), and by Stanley in vol. xxiv. of the *Transactions of the Medico-Chir. Society*.

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* *Traité des Fractures et des Luxations*, 1855, t. ii. p. 8. † Ib. p. 805.

‡ *On Dislocations and Fractures of the Joints*, 5th edition, edited by Bransby B. Cooper.

Dislocations of the hip sometimes take place spontaneously, in consequence of paralysis of the muscles external to the joint, or from disease of the joint itself;* they are also occasionally met with as congenital affections, due to causes acting in utero, or to violence inflicted during birth. In the present essay we have to treat of those dislocations of the hip which result from violence; and they occur most frequently in the following directions:

1st. The head of the bone is thrown upwards, and more or less backwards, upon the dorsum ilii.

2dly. Backwards, and slightly upwards, or into the ischiatic notch.

3dly. Downwards and inwards, or into the obturator foramen.

4thly. Upwards and inwards, or upon the body of the pubes.

The two last varieties of dislocation are, according to Malgaigne, generally incomplete, and even the two former are by no means unfrequently so; hence the precise spot on which the head of the bone rests is seldom, as observed by Fergusson, "the same in any two cases. Upwards, for example, it has been found to range, in different instances, throughout every point between the anterior spinous process and the sacro-sciatic notch, and in the other directions considerable differences in position have been remarked. In one example the limb would appear much shorter compared with its fellow than in another; again, the toes or foot may be more pointed inwards or outwards in one patient than another; and all these circumstances indicate corresponding varieties in the position of the head of the bone."†

The proportion in which these dislocations are met with are, according to Sir A. Cooper, the following: in twenty cases, there will be twelve on the dorsum ilii, five into the ischiatic notch, two into the obturator foramen, and one on the pubes. This accords very nearly with the experience of Syme, who, in eleven cases that came under observation at the Royal Infirmary of Edinburgh, had six on the dorsum ilii, three in the ischiatic notch, one in the obturator foramen, and one in the pubes.* In seventeen cases observed by Malgaigne, eleven were either iliac or ischiatic, four pubic, and two obturator. The last-named Surgeon believes a dislocation into the obturator foramen to be the most rare, and this is also the opinion of Fergusson. Besides the four ordinary dislocations of the hip, some anomalous ones have been described, of which mention will be made presently.

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* Vide Stanley, *Med.-Chir. Transactions*, vol. xxiv.

† Fergusson's *Practical Surgery*, 3d ed. p. 376.

(1.) *Dislocation upwards or upon the dorsum ilii.* In this dislocation the head of the femur is thrown upwards, and more or less backwards, and will occupy different positions in different cases, as already observed. In one case, it has been found lying partly on the bone, partly on the gluteus medius, and partly on the pyriformis muscles; in another, between the gluteus maximus and the posterior border of the gluteus medius; and in another, underneath the inferior border of the gluteus medius, by which it was fixed in its unnatural position. The capsular and round ligaments are necessarily torn through in all complete dislocations; and the former has been found completely detached from its femoral attachments, and partially from its pelvic. The small external rotator muscles of the hip are either put upon the stretch, or some or all of them may be torn across. With respect to the height to which the head of the femur may ascend in these iliac dislocations, Malgaigne found, in eleven preparations of this accident which he examined, that in five it did not ascend higher than a line drawn from the anterior superior spinous process of the ilium to the highest point of the ischiatic notch; in two it ascended half a centimetre (about one-sixth of an inch) higher; in two, one centimetre; in one, one centimetre and a half; and in one, two centimetres. The limits of the displacement below were never lower than the point of junction of the ilium with the ischium; but the limits posteriorly were somewhat greater.

Symptoms. The limb is from an inch and a half to two inches and a half shorter than its fellow; it is inverted, slightly bent, and inclined forwards and inwards; so that when the patient is standing, the knee of the affected side is somewhat in front of, and above the other, and the toes rest on the tarsus of the opposite foot; the great trochanter is directed forwards, and lies nearer to the anterior superior spinous process of the ilium than natural, while the head of the bone is directed backwards, and, in thin persons, may be felt lying upon the dorsum ilii. The only movement of which the limb is capable, unless great force be used, is a slight one in the sense of flexion, adduction, and rotation inwards; its elongation, extension, and abduction cannot be accomplished, and the attempt is productive of great pain.

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* *Monthly Journal,* April 1845.

Causes. This dislocation, according to Sir A. Cooper, is most commonly brought about by a fall whilst carrying a heavy load on the shoulders, or by a heavy weight, such as a mass of earth falling on the back whilst the body is bent forwards in a stooping posture.

Diagnosis. Notwithstanding that the symptoms of this accident are so well marked that it would seem impossible to confound it with any other, it has been supposed to bear some resemblance to a fracture of the neck of the femur, within the capsular ligament; yet the only point in which the two injuries agree is in the shortening of the limb; in almost every other respect they differ. In fracture, the limb is everted, and more movable than in dislocation; it is capable of elongation by moderate extension, but becomes shortened on the remission of the extending force. If slight rotation be made during the extension, crepitus can generally be detected; and the accident occurs mostly in old people, and from slight causes. The comparatively rare cases of fracture of the neck of the femur, with inversion of the limb, are more liable to be mistaken for this dislocation, especially if the fracture through the neck be complicated with one of the great trochanter; a portion of the latter may then be drawn by the action of the muscles towards the great sciatic notch, or upon the dorsum of the ilium, and so resemble the head of the bone in those situations, as, indeed, happened in the following case related by Smith, and which was at first mistaken for a dislocation. The patient was an old man, eighty years of age, who died on the 14th day after the accident. During life the limb was shortened two inches, the foot inverted, and the entire limb in a state of adduction; the trochanter major could be felt upon the dorsum of the ilium, a little above the situation of the sciatic notch. After death, there was found a transverse serrated fracture of the neck of the femur external to the capsule; at the line of junction of the cervix with the shaft of the bone a second fracture detached the trochanter major, which was drawn upwards and backwards, carrying with it the insertions of the pyriformis, gemelli, and obturator muscles.*

An injury more nearly resembling the dislocation in question is fracture of the acetabulum, of which several examples have been given by Cooper, Earl, Malgaigne, Gibb, M'Tyer, and others. The shortening and inversion of the limb which characterised some of these cases was due either to the head of the bone being driven through the acetabulum into the pelvis, or to its escape from the acetabulum, through a fracture of the superior and posterior border of that cavity. Such cases may be distinguished from dislocation by the existence of crepitus, the greater severity of the other symptoms, and in the case of the fracture of the cotyloid border, by the spontaneous recurrence of the dislocation after reduction. Contusions, sprains, spasm of the muscles of the hip, rheumatism, and scrofulous disease of the joint, have all been occasionally mistaken for dislocation, and treated accordingly. Cases have been met with in which the two limbs were of the same length; this may happen either from both hips being dislocated, or from the thigh on the uninjured side being shortened from a previous fracture. But besides errors of diagnosis, errors of omission may be committed, and a dislocation may be overlooked, if it happen under peculiar circumstances, or be complicated with other injuries. "A young woman, about her full time of pregnancy, had a severe fall, and was carried to bed in a helpless condition; labour came on immediately after, and she had a difficult time. A severe rheumatic fever, as it was supposed, came on, and for some weeks her life was despaired of. Mr. Fergusson was asked to see her when she was comparatively well, about three months after the accident, and then, for the first time, a dislocation of the hip was detected."† The same Surgeon also relates another case, where a dislocation was complicated with a fracture of the femur in its lower third, and the dislocation was not detected till it was too late to attempt its reduction.

Treatment. In the treatment of this and other dislocations of the hip, our first object must be to diminish as far as possible the resistance of the muscles; and our second, to fix the trunk of the patient so firmly that it shall not yield to the extending or other forces which may be employed for the reduction of the limb. The first of these objects is best attained by the administration of chloroform or ether; but in default of these, the patient should be placed in a warm bath heated to 100°, and this may be gradually raised to 110°, so as to produce faintness; or tartar-emetic may be given to the extent of exciting nausea and prostration.

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* Op. cit. case 20, p. 85. See also similar cases by Stanley in the 13th vol. of the *Med.-Chir. Trans.* p. 504.

† Fergusson, op. cit. p. 382.

The trunk may be fixed in a variety of ways; but the common jack-towel, or a folded sheet, answers every purpose, and may be thus applied. The patient being first laid on his back on a firm mattress placed on the floor or a low table, the sheet must be passed between the dislocated thigh and perinæum, and its ends fastened to a staple firmly fixed to the floor or wall behind the patient, and somewhat below him, so as to be in a line with the axis of the displaced limb; or a strong well-padded leather girth, with an opening in it sufficiently large to admit the injured extremity, and to press on the perinæum on one side and the crest of the ilium on the other, may be substituted for the sheet. The trunk being thus securely fixed, a padded leather belt, with straps and rings attached, is to be tightly buckled to the thigh above the knee, or a jack-towel may be fastened to the limb, previously protected by a wet bandage, by means of the clove-hitch. The knee being now slightly bent and brought across the opposite thigh, one end of a multiplying pulley should be fixed to the rings of the leather belt or towel, and the other end to a staple fixed in the wall in front of the patient. The extending and counter-extending forces being thus adjusted in the axis of the displaced limb, traction should be slowly made with the pulley till the head of the bone has approached the acetabulum, when on the Surgeon gently rotating the limb inwards, the bone usually slips into its place. If difficulty occur in raising the bone over the acetabulum, Sir A. Cooper recommends a towel to be placed under the thigh, as near the joint as possible, so that the bone may thus be lifted over the edge of the socket. It is said that when pulleys are used the head of the bone slips into the acetabulum without any audible snap, so that there are no means of judging whether the bone is in its place, except by relaxing the extension, unloosening the apparatus, comparing the length of the two limbs, and ascertaining that the relative position of the trochanters to the spines of the ilia are alike. Though it is undoubtedly true that a distinct snap is not always heard at the moment of reduction, there is generally a peculiar sensation conveyed to the hands which cannot be mistaken; it is desirable, therefore, that the Surgeon should have hold of the limb while extension is being made, not only for aiding by his manipulations the reduction of the bone, but for recognising its return into the socket. When this is accomplished, the movements of the joint will be found to be perfectly restored; and this is the best, and indeed the only test of reduction which is necessary. The after-treatment consists in placing a long straight splint on the outer side of the limb, in the same way as in a fracture of the thigh, except that the extension should be dispensed with. The object of this treatment, which should be continued for three or four weeks, is to keep the joint motionless, and so permit the injured parts to heal and prevent the escape of the bone anew from its cavity, as once happened in a case under Mr. Liston's care. As great force is often required to reduce these dislocations, especially when of long standing, it should not be forgotten that accidents have happened, and even life has been sacrificed in the attempt. A fracture of the cervix femoris, produced by an attempt at reducing a dislocation on the dorsum ilii, has been recorded by Sir A. Cooper; and Lisfranc once carried his efforts at reduction so far, that suppurative inflammation was set up in the hip, and the man died, with his thigh unreduced, on the eleventh day after the attempt.

The above means for reducing this dislocation may sometimes be dispensed with, and the limb reduced either by manual extension or by simple manipulation. Perhaps the best mode of effecting the former is by placing the foot in the perinæum of the side affected, and using it as a counter-extending force, while with the hands the thigh is grasped just above the knee; or, what is better, let a jack-towel be fixed to it by means of the clove-hitch, while the other end of the towel is carried round the shoulders of the Surgeon; the latter should then incline backwards at the same time that his foot is making increasing pressure in the perinæum; this, with slight rotation of the limb, has proved successful in several dislocations reported by the late Mr. Morgan and Mr. Cock, in *Guy's Hospital Reports*.*

The method of reducing a dislocated limb by manipulation has been practised from the earliest times; but it has been again revived of late years, and consists in making use of the dislocated limb as a lever, and either moving it with a pendulum-like movement from side to side, and from before backwards, while the patient stands on the sound limb, resting his hands on a table, till the head of the bone slips into the socket (Colombot's plan),† or in abducting it from the mesial line, as practised by Dr. Mayr and Dr. Fischer of Cologne, and others;‡ or in flexing it on the pelvis, as recommended by Dr. Reid of Rochester, U.S., who reduces dislocations on the dorsum ilii and into the ischiatic notch by first flexing the leg on the thigh, and then the thigh on the pelvis, obliquely towards the sound side; the limb is then abducted and rotated outwards.* Mr. Cock and Mr. Wormald have both succeeded by this method, or a slight modification of it, in reducing dislocations of the hip which have resisted the ordinary means; and the former gentleman gives this formula for the reduction,—lift up, bend out, roll in.†

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* Vol. i. p. 79. † Malgaigne, op. cit. tom. ii. p. 825.

‡ *Dublin Med. Press*, Dec. 3d, 1851.

A question which the Surgeon will sometimes be called on to decide is, How long after a dislocation of the hip may its reduction be attempted? and on this point authorities differ. Much must necessarily depend on the age and constitution of the patient, and something on his own wish in the matter. Fabricius Hildanus mentions the case of a lady of rank, in whom reduction was attempted fifteen weeks after the accident, but without success; it has, however, been accomplished after the lapse of six months,‡ twelve months,§ and even longer, as in the remarkable case of Mr. Cornish, related by Sir A. Cooper. Under ordinary circumstances, a reduction of the hip is hardly to be looked for later than eight weeks after the accident, which was the limit placed by the distinguished Surgeon just named, beyond which it should not be attempted. Fergusson has never witnessed a successful effort beyond the period of three weeks; but he would deem it quite correct to make trial of all reasonable means at a much longer date, though he could not be at all sanguine of success after two or three months. More important than the determination of the longest period at which reduction of this dislocation may be attempted, is the line of practice to be pursued where the injury is complicated with a fracture of the femur of the same side. Guy de Chauliac laid down the following general rule. When a dislocation is complicated with a fracture, let the dislocation be first reduced and then the fracture, if that is possible. But if it is not possible, let the fracture be first reduced, and after the callus is firm, the dislocation.|| Boyer considered that a dislocation of an orbicular joint could not be reduced if a fracture were present, and that when the latter had united, the reduction of the dislocation could not be effected, owing to its age. However, Sir A. Cooper relates a case (29th) in which reduction was effected five weeks after the double accident, the fractured bone having become suffi-

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* *Buf. Med. Journ.* vol. vii. p. 129.

† *Medical Times and Gazette*, June 30, 1855; ib. Aug. 16 and Sept. 6, 1856.

‡ Gockelius, *Galliciniun Medico-practicum*, Ulm, 1700, p. 288.

§ Malgaigne, tom. ii. p. 821; Cooper, case 64.

|| Malgaigne, tom. ii. p. 203.

ciently firm in this time to admit of extension being made; but this occurred in a youth sixteen or eighteen years of age, and it is doubtful whether the same success would have been attained had the patient been older. The rule would seem to be this: whenever there is room enough above the fracture to fix securely an extending apparatus, reduction of the dislocation should be first attempted, and afterwards the fracture. Several cases are now upon record in which this practice has been successfully carried out; thus, Bloxam reduced a dislocation upon the pubes on the eighth day after the accident;* and M. Etène one into the ischiatic notch, the fracture being in the centre of the bone.† In every attempt of this nature, the limb should be first firmly encased in splints, and preference given to the abduction and flexion plan of reduction.

2. *Dislocation backwards, or into the ischiatic notch.* In this dislocation the head of the bone is thrown slightly upwards as well as backwards, and rests on the pyriformis muscle. According to Malgaigne, who is followed by Erichsen, it is merely a variety of the dislocation on the dorsum ilii; while Boyer considered it consecutive on this dislocation. The symptoms very closely resemble those of the dislocation upwards, but are less marked. Thus the shortening of the limb rarely exceeds half an inch; its adduction, inversion, and flexion are less; so that in standing the knee projects but slightly beyond the other, and the point of the great toe rests on the ball of the great toe of the opposite foot, instead of on the tarsus. The trochanter is somewhat behind and above its normal position, but remains nearly at right angles with the ilium, while the head of the bone is so buried in the ischiatic notch that it cannot be felt. The limb is fixed, and all voluntary movements are abolished.

Causes. These are the same as produce the dislocation upwards, viz. the application of force when the body is bent forwards upon the thigh, or when the latter is bent at right angles with the abdomen. The opinion of Boyer, that this dislocation is consecutive on the dislocation upwards, is highly improbable, indeed the converse would seem much more likely; but that in our attempts to reduce a dislocation upwards, the head of the bone may slip into the sciatic notch, there is abundant evidence; and it may be stated generally in reference to the dislocations of the head of the femur, that if our efforts at reduction are mal-directed, they may result in converting one form of dislocation into another.

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* *Gazette Médicale*, 1833, p. 660.

† Ibid. 1838, p. 751.

The reduction of this dislocation may be effected in nearly the same way as the dislocation on the dorsum ilii, the chief points of difference being, that the patient should be placed on his sound side instead of on his back; that the direction of the extension should be across the middle of the sound thigh instead of immediately above the knee; and lastly, that the head of the bone should be assisted over the edge of the acetabulum, by means of a round-towel placed under the upper part of the thigh and over the shoulders of an assistant, who, at the same time resting both his hands on the patient's pelvis, gradually raises his body, and so lifts the bone into its socket. Notwithstanding the reduction of this dislocation is pronounced by Sir A. Cooper to be in general extremely difficult, the cases which he has given in illustration scarcely bear out his assertion. This is one of the forms of dislocation of the hip in which the flexion method of reduction has been practised with great success, after the ordinary means had failed. Thus Mr. Wormald succeeded six weeks after the accident, and when pulleys had been used in vain.*

3. *Dislocation downwards, or into the obturator foramen.* In the dislocation downwards, the head of the femur is thrown into the obturator foramen, and lies upon the obturator externus muscle; the round and capsular ligaments are torn through, and the psoas and iliacus muscles, together with the glutei and the pyriformis, are put on the stretch.

Symptoms. The limb is lengthened to the extent of about two inches; it is abducted and advanced in front of the other; the foot is pointed forwards, and neither inwards nor outwards; the trochanter major is less prominent than natural; and there is a slight concavity at the upper and front part of the thigh, behind which the head of the bone can be felt on making deep pressure; the body is bent forwards and somewhat to the injured side by the psoas muscle. The limb cannot be adducted or extended without some force, and this movement causes pain and numbness.

Causes. Any accident by which the thighs become suddenly and violently separated from each other, is sufficient to produce this dislocation; hence it has happened from heavy weights, as a mass of earth falling on the back and forcing the limbs apart. Pirrie saw it caused by a person jumping out of bed in great haste, whose right foot was entangled by the blankets in bed while the left foot reached the floor.* It has also been known to occur from the sudden movement of a carriage which a person was in the act of mounting, having one foot on the ground, and the other on the step of the vehicle.

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* *Medical Times and Gazette*, Aug. 16, 1856.

Treatment. The reduction of this dislocation is not difficult, and may be accomplished in the following manner: If the dislocation be recent, Sir A. Cooper recommended that the patient should be laid on his back, and the pelvis fixed by a girth, which is made completely to surround both ilia, while its ends are fixed to a staple placed on the opposite side to the injured limb. Another girth is to be placed between the pudendum and the upper part of the luxated thigh, and its ends carried underneath the other so that the two shall interlock. A pulley being now attached to these ends, extension must be slowly made, in a direction obliquely upwards and outwards, until the head of the bone begins to move from its abnormal position. The Surgeon must then grasp the ankle of the dislocated limb and draw it towards and behind its fellow, when the bone usually slips into its place. Another mode of reducing this dislocation is by making the patient sit astride of a bed-post, or a wooden pillar fixed on a table or let into the floor; the limb is then slightly extended, and crossed over the sound one, when reduction usually at once follows. A third plan has also been tried with success in several cases, namely, flexing the thigh on the pelvis, and at the same time rotating it outwards. In this manner Mr. Wormald succeeded in reducing this dislocation twenty-five days after the accident.† Care must be taken in the two first methods of reduction not to raise too much the dislocated limb while adducting it, or the head of the bone may be thrown into the ischiatic notch.

4. *Dislocation upwards and inwards, or on the pubes.* Notwithstanding this dislocation is usually designated as the dislocation on the pubes, the head of the femur does not rest so much on that bone as on the ilium, hence the term ilio-pubic, which is applied to it by Malgaigne, is the more correct designation. In an old dislocation of this nature, dissected by Sir A. Cooper and figured in his work, the head and neck of the bone occupied a position beneath the psoas and iliacus muscles, and the anterior crural nerve, and external to the femoral artery and vein. The capsular ligament was extensively lacerated, and the ligamentum teres torn through. Upon the pubes (qy. ilium?) a new acetabulum was formed for the neck of the thigh-bone, the head of the bone being above the level of the pubes.

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* Pirrie, *Principles and Practice of Surgery*, p. 320.

† *Medical Times and Gazette*, Aug. 16, 1856.

Symptoms. The limb is everted, abducted, and shortened to the extent of an inch; it cannot be rotated inwards, but can be slightly flexed in a direction outwards and abducted. The head of the bone can be felt in the groin generally to the outer side of the femoral artery, and sometimes it forms a very distinct projection; the great trochanter lies nearer to the mesial line and to the anterior superior spine of the ilium than natural, and the roundness of the hip is consequently lost. This accident can be readily distinguished from a fracture of the neck of the femur by the greater immobility of the limb, but, above all, by the situation of the head of the bone in the groin.

Causes. A sudden forcing of the body backwards while the thighs are fully extended, or a sudden and forcible extension of the thighs while the body is fixed, or a sudden and simultaneous extension of both body and thighs. More rarely this dislocation has been caused by sudden abduction of the limb, combined with rotation outwards. The dislocation has been brought about by a person unexpectedly putting his foot into a hollow in the ground, when, to prevent falling forwards, he throws his body backwards, and the head of the femur is thus tilted out of its cavity upon the pubes or ilium.

Treatment. Most English Surgeons, following Sir A. Cooper, direct the patient to be placed on his uninjured side, counter-extension to be made upwards and forwards in front of his body, and extension downwards and backwards behind the axis of the body. After this has been continued for some time, a towel is to be placed under the upper part of the thigh, so as to lift the head of the bone over the edge of the acetabulum. Malgaigne objects to this method of reducing the dislocation, especially the carrying the thigh backwards, which he affirms tends to tighten and rupture the psoas and iliacus muscles, which are stretched in front of the head and neck of the displaced bone; he recommends as preferable, on every ground, the flexion method, with which he combines direct pressure on the head of the bone, rotation inwards, abduction, and slight traction.

Anomalous dislocations of the hip-joint. Upwards. Among the so-called anomalous dislocations are two forms of displacement upwards, the sus-cotyloïdien of Malgaigne. In one of these, the head of the bone occupies the notch between the anterior superior and the anterior inferior spine of the ilium, the trochanter being directed backwards; in the other, the head of the bone is situated immediately above the margin of the acetabulum between this and the anterior inferior spine of the ilium, or a little to the inner or outer side of this position. The symptoms of the first kind of dislocation, as described by Dr. Cummins, were the following: the limb was shortened fully three inches, and could not be lengthened by extension; the knee and toes were very much turned out, and the attempt to rotate the thigh inwards produced exquisite pain. Abduction and adduction were nearly equally difficult and painful, but flexion could be made to a certain extent with less difficulty. The hip was flattened, and the trochanter major could not be discovered. Close below the anterior superior spine of the ilium there was a hard round tumour, which moved in unison with the movements of the thigh, and was therefore presumed to be the head of the bone. This dislocation occurred from a fall off a bank into a field several feet below. The patient was a thin, spare man; and the reduction was accomplished eleven days after the accident in the following manner. Nausea having been excited by tartar-emetic, extension and counter-extension were made by means of pulleys; a round towel was next placed under the thigh, and while this was raised from its position the knee was pressed towards the opposite thigh, and forcibly rotated inwards.* Of the second form of dislocation upwards there have been several cases recorded. The symptoms are a shortening of the limb to the extent of two inches, with slight abduction and strong rotation outwards. The trochanter major is directed backwards and cannot be felt, and the head of the bone is situated below the anterior inferior spine of the ilium. A slight variation, however, has been observed in the symptoms, corresponding with the position of the head of the bone. The reduction of the dislocation has been accomplished by extension and counter-extension, combined with rotation inwards; it has also been effected by flexion, adduction, and rotation inwards.

Dislocations downwards, or sous-cotyloïdien of Malgaigne, vary as much as the dislocations upwards. Ollivier was the first to give a description of one of these forms of dislocation, which was met with in 1819, but not published till 1823;† it happened from a blow on the inner and lower part of the right thigh, by which the limb was strongly driven outwards, and remained abducted, slightly flexed, and rotated inwards; the head of the bone could not be felt any where, and there was a hollow in the situation of the great trochanter. By imitating on the dead subject the mode in which the displacement took place, Ollivier found that the head of the bone was thrown immediately below the acetabulum, and rested partly in the notch for the tendon of the obturator internus muscle, and partly on the upper part of the tuberosity of the ischium. In another case described by Gurney,* the head of the femur could be felt below and somewhat behind the cotyloid cavity. The limb was upwards of an inch longer than its fellow, and could be rotated both inwards and outwards; but the thigh could not be flexed, and the patient was unable to sit, though he could walk. The late Mr. Keate† met with a case in 1832, which occurred from a horse falling backwards with his rider into a narrow ditch, where both remained nearly a quarter of an hour, the horse's heels in the air, and his back next to the gentleman's thigh. The limb was from three to three and a half inches longer than the other, and strongly abducted and everted; the thigh was much flexed on the pelvis, and the leg on the thigh; the trochanter was sunk into a hollow, and the head of the femur was lying close to, and on a level with, the tuberosity of the ischium, where it could be felt, and even moved, by the fingers. It is believed that the luxation was first into the thyroid foramen, and that afterwards, by the struggling in the ditch, the head of the bone was thrown into the situation in which it was found by Mr. Keate. The reduction was accomplished in two stages. The head of the bone was first brought from the tuberosity of the ischium into the obturator foramen by means of extension and counter-extension, and thence, by a renewed effort, combined with drawing the upper part of the femur outwards, and pressing the knee sharply inwards, it was replaced with a snap in the acetabulum.

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* Cooper, case 65. † Ollivier, *Archiv. de Méd.*, 1823, tom. iii. p. 515.

In addition to the anomalous luxations upwards and downwards just described, the head of the bone has been found thrown backwards, resting on the spine of the ischium or a little below this—the ischiatic dislocation of Malgaigne. It is undoubtedly a rare form of luxation; yet there are, scattered throughout the various medical journals, English and foreign, numerous examples of it, and, more fortunate still, the dissection of the parts injured. Malgaigne has, with much industry, collected these scattered records, and, from a comparison of one with another, it would seem that in eight out of ten cases the head of the bone was on a level with the spine of the ischium, half of it being above and half below that process, while in the remaining two it was a little below. In the greater number of cases the laceration of the capsule was below, or below and behind; the muscles most frequently torn were the quadratus and then the gemelli; while in two cases the quadratus was uninjured, and in one all the other external rotators except this were lacerated and completely torn through. From a comparison of the preparations of this form of dislocation with those on the dorsum ilii and into the sciatic notch, it would appear that they differ from the latter chiefly in the head of the bone escaping from the capsule below the obturator internus muscle; hence the luxation we are now treating of may become afterwards, and in consequence of the rupture of this muscle, converted into a dislocation into the ischiatic notch, or on to the dorsum of the ilium, and conversely, either of the latter may become subsequently, in the attempts to reduce them, ischiatic. The symptoms of this dislocation resemble greatly those of the dislocation into the ischiatic notch, and the two have not unfrequently been confounded. The limb is but very slightly shortened, the thigh is flexed, adducted, and rotated inwards; the head of the bone projects backwards above the tuberosity of the ischium, though in some cases it could with difficulty be felt, and the circumference of the thigh at its highest part is increased. The limb can be flexed slightly, but not rotated outwards. Reduction of this luxation is to be effected by extension and counter-extension, made in the direction of the axis of the deformed limb; and with this is to be combined rotation of the thigh outwards, and pressure on the head of the displaced bone.*

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* *Lancet*, 1845, vol. i. p. 412.

† *Med. Gaz.* 1832, vol. x. p. 19.

Dislocations of the Patella

are not of very frequent occurrence, but they may take place in the following directions, viz. outwards, inwards, upwards, and edgeways; they may be complete or only partial, and are more frequently produced by muscular action than any other dislocation, if we except the lower jaw.

Outwards. This is by far the most common variety of the accident, and may be occasioned either by muscular action or by direct violence; thus, it has been known to take place from a sudden jump on one side to avoid being run over; from wrestling; but more frequently from falling down and striking the inner side of the knee. It is said to occur generally to those who have a slight inclination of the knee inwards; but Malgaigne found only one patient so affected out of forty-six cases of this luxation. The deformity occasioned by this dislocation is considerable; the knee is broader than the other, and, in place of the projection formed by the patella, there is a depression; the displaced bone can be felt lying on the outer condyle; the leg is extended, or very slightly flexed, and any attempt to move it from this position causes great pain.

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* Cases of this form of dislocation are reported in the following journals: Scott, *Dublin Hospital Reports*, 1822, vol. iii. p. 389; Wormald, *Medical Gazette*, Jan. 1837, p. 657; Travers, *Med.-Chir. Trans.* 1837, vol. xx. p. 112; Syme, *Monthly Journal*, 1843, p. 498; Quain, *Med.-Chir. Trans.* 1848, vol. xxxi. p. 337; Adams, *Dublin Hospital Gazette*, 1855, vol. i. p. 146.

The dislocation *inwards* is very rare, and seldom complete, and happens usually from falls on a projecting body, by which the patella is struck on its outer edge, and so driven inwards. The symptoms resemble those of the dislocation outwards, but the projection of the patella is of course in front of the inner instead of the outer condyle.

Treatment. This consists in placing the patient in a sitting posture, raising the limb towards the trunk, and then pressing the patella inwards or outwards, according to the nature of the dislocation. Forcibly flexing the knee while the limb is in the above position is another mode of reducing these luxations.

In the dislocation *edgeways* the patella is turned on its axis, so as to bring its lateral margins forwards and backwards, and its surfaces sideways; indeed, in some instances this has taken place to such an extent as almost to reverse the normal position of the two surfaces. According to Malgaigne, it is the outer edge of the bone which is most frequently directed backwards, being buried in the fossa between the condyles. There is no difficulty in detecting the nature of these dislocations; the patella can be easily felt in its unnatural position, causing a projection in front of the joint, and a depression on each side, while the joint is immovably fixed in an altered position. This, like the other forms of dislocation of the patella, has been known to occur from muscular action, as in jumping; but most frequently it has resulted from a sudden blow applied to the patella while the knee was bent, as in Mr. Mayo's case, related by Sir A. Cooper, of the life-guardsman, in whom the injury was caused by the knee of another soldier, as the opposite lines rode through each other.

In a case related to me by Mr. Flower, the patient, a young man, aged twenty-two, was stepping over the seats of the gallery of a theatre, and fell between them, without, so far as he was aware, striking the knee; severe pain and inability to flex the joint were the immediate results. On examination Mr. Flower found the patella twisted on its longitudinal axis, with its outer edge projecting forwards under the skin, and its inner edge wedged in between the condyles of the femur and the head of the tibia. The limb was extended, and all attempts at reduction by bending the knee, manipulating the patella, &c. produced great pain, and were unavailing till chloroform was given, when, on bending the knee, the bone directly slipped back into its place.

Treatment. In the cases just alluded to, reduction was effected by suddenly bending the knee. In other cases the same result has been obtained by pressing the edges of the bone in opposite directions while the leg was extended; and in others, both these means, and even the more violent ones of dividing the quadriceps muscle and the ligamentum patellæ, opening the joint, and endeavouring to raise the bone from its position by an elevator, have all failed. The extreme difficulty that has been experienced in the reduction of some of these dislocations is supposed to arise from the upper extremity of the bone having become firmly wedged in the intercondyloid notch.

The dislocation of the patella *upwards* is an exceedingly rare accident, and cannot take place without a rupture of the ligamentum patellæ; this is most usually brought about by a sudden and violent contraction of the quadriceps muscle, made in an effort to prevent falling backwards; the dislocation has also taken place from division of the ligament by sword-cuts, and by falling with the knee on broken glass. The nature of the accident is at once obvious, from the position of the patella, the hollow beneath it, and the inability of the patient to bear the weight of his body on the limb. It is usually followed by a good deal of inflammation of the joint, which should be first subdued, and the dislocation then be treated in all respects as a fracture of the patella.

Dislocations of the Knee-joint.

The tibia may be displaced laterally, or forwards and backwards; each of these dislocations may vary in degree; but the former are always partial, and the latter generally complete; they are usually combined with a slight rotation of the tibia on its axis.

Lateral dislocations. In these the head of the tibia is partially displaced from the condyles of the femur in a lateral direction. In the dislocation outwards the inner articular surface of the head of the tibia is driven on to or towards the external condyle of the femur, causing much deformity, from the leg and thigh being no longer in the same axis. In the dislocation inwards the outer articular surface of the head of the tibia is displaced towards the internal condyle, producing an analogous deformity.

The *causes* of these dislocations are falls on the feet, sudden twists of the knee-joint, or blows directed laterally against the lower end of the femur. The deformity which accompanies them is so characteristic of their nature that a mistaken diagnosis is not likely to occur. They are easily reduced by moderate extension, combined with rotation, or by pressing the displaced tibia into its natural position.

Dislocations in the antero-posterior direction cannot take place without the application of great force. The dislocation of the tibia forwards is most frequently brought about by a forced extension of the knee-joint, or by a heavy body striking the lower and front part of the thigh while the limb is extended. The dislocation backwards is usually the result of direct violence applied to the upper and front part of the tibia when the knee is bent. In both of these displacements considerable injury is done to the soft structures of the joint, and the muscles in the neighbourhood are sometimes torn through. In the dislocation forwards the popliteal artery is also more or less compressed, and has led to subsequent gangrene of the limb. The symptoms of the dislocation forwards are a swelling in the ham, produced by the condyles of the femur, and another on the front and lower part of the thigh, caused by the head of the tibia, while a depression exists below the former bone and above the latter. The limb is shortened to a variable extent, according as the tibia is higher or lower in front of the femur. In the majority of cases the limb is extended, but in some it has been flexed; the mobility also varies from almost complete fixity to a considerable amount of motion in every direction. In the dislocation backwards, the head of the tibia forms a projection in the ham, and a deep depression exists in front of the knee, below the projecting condyles of the femur. Thus there are the same projections and depressions as in the last-described accident; but their position is reversed. The limb is extended and shortened, and the patella is placed horizontally, with its anterior surface looking downwards and its upper margin forwards. This dislocation is more rare than the preceding one.

Treatment. The reduction of these dislocations is not difficult; extension must be made from the ankle, in the axis of the displaced tibia, and counter-extension from the thigh, aided, if necessary, by pressing the condyles of the femur upwards, and the head of the tibia downwards. After reduction is accomplished, the joint must be kept perfectly motionless for two or three weeks, and the ordinary remedies employed for preventing or subduing inflammation.

Sub-luxations of the semilunar cartilages. Inflammation of the knee-joint is liable to be followed by enlargement of the semilunar cartilages, and by elongation of the ligaments which connect them with the tibia. Under these circumstances, a trivial accident, such as striking the toe against some projecting object while the foot is slightly everted, as in walking; or even turning suddenly in bed, should the clothes happen to catch the point of the foot, may cause a displacement of the cartilages, and bring the condyles of the femur into direct contact with the head of the tibia. The symptoms which this gives rise to are a sudden and severe pain in the joint, with inability to straighten it, followed in a short time by the effusion of fluid, and the usual symptoms of synovitis. Bassius recorded a case of this description in 1731. It happened in a female, who had previously been the subject of severe inflammation of the joint, which ended in enlargement of the external semilunar cartilage. One day, on attempting to put the limb to the ground, she fell down; and Bassius, who was called in, found the cartilage greatly enlarged, and projecting outwards; it was reduced by pressure, but required a plaster and bandage to retain it in its place.[*] Somewhat similar cases, attended with a marked projection of the internal semilunar cartilage, have been recorded by Malgaigne and by Dequevauviller;[†] Hey[‡] and Sir A. Cooper,[§] on the contrary, observed no projection or other deformity; so that the symptoms may have been due to the existence of loose cartilages in the joint. M. Gimelle[||] has related a case in which this mistake was made; but the true cause having been at length discovered, Larrey cut into the joint and removed the foreign body. Reduction is generally easily accomplished by flexing the knee to its utmost extent, and then suddenly straightening it, imparting to the leg at the same time a slight rotatory movement. Should these manipulations succeed, the patient will be able to extend his limb and move it freely; but the plan is not invariably successful, and it then becomes necessary—all other means of reduction failing—for the patient to wear constantly a bandage or knee-cap firmly around the joint. Even when reduction is effected, similar support of the joint is required, in order to prevent a return of the accident, to which persons who have once suffered are particularly prone. In all cases some degree of inflammation of the joint is set up, which requires the usual treatment for synovitis.

Compound dislocations. These injuries are among the most serious to which the limbs are liable; for, to the danger incidental to every wound of a large and healthy joint, there is superadded that arising from the forcible separation and displacement of the bones which compose it, and the extensive laceration of the soft structures of and around the joint, including sometimes the popliteal artery. For these reasons it is seldom possible to save the limb, and rarely advisable to make the attempt; nevertheless, if the subject of the accident be young and of good constitution, if the wound in the integuments be small, and the soft parts around the joint not much bruised or the popliteal artery injured, an attempt may reasonably be made to preserve the limb.

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[*] Malgaigne, t. ii. p. 968.

[†] *Rev. Méd.-Chir.* t. vi. p. 180, t. vii. p. 311.

[‡] Hey, *Observations in Surgery*, pp. 327 et seq.

[§] Cooper, op cit. p. 212.

[||] *Gazette Médicale*, 1835, p. 221.

Dislocations of the head of the fibula have been occasionally met with, both from relaxation of the ligaments which connect it with the tibia, and from rupture of the same by violence.* Reduction is effected by flexing the leg, so as to relax the biceps, and then pushing the head of the bone into its place; after reduction, a compress or cushion must be firmly fixed behind the head of the bone, so as to retain it in position, and it should be kept on for six weeks or two months.

Dislocations of the Ankle-joint.

In these dislocations there is a separation of the articular surface of the lower end of the tibia and of the upper surface of the astragalus, and much ingenuity has been expended in discussing whether it is the tibia which is dislocated from the astragalus, or the astragalus from the tibia. If the foot were fixed in a vice, and force applied to the leg, the tibia might be separated from its connexions with the astragalus, and the injury be called with perfect truth a dislocation of the tibia. If the leg were fixed in the same way, and force applied to the foot, the astragalus might be separated from its connexions with the tibia, and the injury with equal truth be called a dislocation of the astragalus or foot; but if instead of fixing either leg or foot, force were applied equally and simultaneously to both, as happens perhaps in the majority of these luxations, the separation of their articular surfaces would be mutual, and neither of the above terms would be strictly correct. It is absurd, therefore, to dispute about which is the bone dislocated; neither would it be possible to adopt the *mode* of displacement as a basis of nomenclature. In all other dislocations, the distal part of the limb is assumed to be displaced, and the proximal end to be in its place; but in the case of the ankle-joint this rule has been arbitrarily set aside, without any equivalent advantage. On the contrary, it has given rise to much confusion of terms, the same accident being differently designated according to the views of the Surgeon describing it. Sir A. Cooper, and most English Surgeons, speak of the tibia as the bone displaced; while Petit, Boyer, and the majority of French Surgeons, refer the displacement to the astragalus: hence the dislocation inwards of the English would be the dislocation outwards of the French. Not less confusion prevails in the designation of the luxations of the calcaneo-astragaloid joint; one writer calling them dislocations of the astragalus, another dislocations of the foot, and a third using these terms synonymously; whilst the majority make no distinction between those cases in which the astragalus maintains its connexion with the bones of the leg and is dislocated only from those of the tarsus, and those in which it is separated from both. In the description of these several accidents, therefore, the following terms will be employed. The separation between the astragalus and the tibia will be called a dislocation of the foot at the ankle-joint; the separation between the astragalus and the os calcis and scaphoid will be spoken of as a dislocation of the foot at the calcaneo-astragaloid joint; while the term dislocation of the astragalus will be confined to the separation of this bone both from its tibial and tarsal connexions.

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* See p. 656, for a remarkable case of this dislocation.

Dislocations of the foot at the ankle-joint may take place in the following directions, placed according to their frequency—outwards, inwards, backwards, and forwards. In the dislocation *outwards* the fibula is broken from two to three inches above the malleolus; the foot is everted, and its outer edge raised, whilst its inner rests on the ground; a hollow exists at the seat of the fracture, and the extremity of the tibia projects on the inner side of the joint, immediately beneath the skin. Besides the fracture of the fibula, which nearly always accompanies this dislocation, the internal lateral ligament is sometimes torn through, and there may be detached with it more or less of the internal malleolus; or the lower end of the tibia may be broken very obliquely, one portion of it remaining attached to the fibula, where it is connected with that bone by ligament. There is a remarkable if not a unique case, related by Boyer, in which this dislocation was unaccompanied by a fracture of the fibula; but in lieu of this, the entire bone was forced upwards, and its head dislocated from the articular facet of the tibia.*

Simple dislocation of the foot *inwards* is a rare and rather severe accident; greater force being required to produce it than the dislocation outwards; hence, in addition to the tibia being generally obliquely fractured through the malleolus, and separated from the shaft, there may also be a fracture of the astragalus, and of the outer malleolus. If there be no fracture of the latter, the external lateral ligament will be torn through; but the deltoid remains unaffected by the displacement. The symptoms of this injury are, inversion of the foot, a great prominence of the outer ankle, which almost touches the ground, and a depression on the opposite side of the ankle.

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* Boyer, *Maladies Chirurg.* tom. iii. p. 883.

Both of these lateral dislocations are occasioned by a sudden twist of the foot outwards or inwards, as in jumping or falling from a height on the foot; and their reduction may be accomplished by extension made from the foot, the leg and thigh being previously flexed, so as to reduce to a minimum the resistance of the muscles. Two side-splints, with foot-pieces made of wood, leather, or gutta-percha, or the starch-bandage strengthened with millboard, must be applied and kept on for six weeks, the patient being allowed to go about upon crutches.

Dislocation of the foot *backwards* may arise from jumping off a carriage in motion, or from a fall backwards whilst the foot is confined; from either cause, the capsular and part of the deltoid ligaments may be ruptured, the fibula broken above the malleolus, and the tibia forced from the astragalus on to the navicular and cuneiform bones. The symptoms of this accident are, a shortening of the foot and a lengthening of the heel, with a depression above the latter. The toes are pointed downwards, and the extremity of the tibia forms a projection in front of the ankle. Reduction may be accomplished in the same manner as in the last-described dislocation, and a similar apparatus is sufficient for the after-treatment.

Dislocation of the foot *forwards* is so rare that Sir A. Cooper never saw a case, and but few such are on record. One of the best-described cases is that recorded by Mr. R. W. Smith, of Dublin.* The subject of the accident was a sailor, who, while assisting to raise a very heavy cask on board ship, having at the same time one leg much flexed on the foot, and the thigh on the leg, was struck by the falling of the cask just above the knee, forcing the distal end of the tibia backwards from off the astragalus on to the upper and posterior surface of the calcaneum. The symptoms of this accident were, a lengthening of the dorsum of the foot to the extent of one inch, and a shortening of the leg to the extent of half an inch, the two malleoli being that much nearer the ground. The projection of the heel had disappeared, and the tibia formed a remarkable projection in front and to the inner side of the tendo Achillis. The fibula was uninjured; but the extremity of the inner malleolus had been fractured. The only accident with which this could be confounded is a fracture of the tibia immediately above the ankle-joint; but the situation of the malleoli would be decisive as to the nature of the injury. In the few cases of this accident which have been published, reduction was not effected, and the patients remained very lame; but there seems to be no reason why cases of this description, if seen early and properly recognised, should not be reduced in a similar manner to the lateral dislocations, and treated in all respects similarly.

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* *Dublin Quarterly Journal of Medical Science*, May 1852.

Compound dislocations of the foot at the ankle-joint take place in the same directions as the simple dislocations, and are accompanied by similar injury to the ligaments and bones of the joint. There is, however, superadded the wound in the integuments communicating with the joint, and there may be also laceration of the blood-vessels and tendons, and extensive comminution of all the bones of the joint, and even of the os calcis.

Respecting the nature of these injuries there can be no doubt, and the only question is as to their treatment. It would be impossible to lay down rules for every case; each must be studied separately, and the means adapted to the circumstances present. If arteries are wounded and bleeding, they must be tied; if bones are comminuted, the pieces must be removed; resection may be required in some cases, and amputation in others. As a general rule, amputation is improper, and, except under the circumstances to be presently mentioned, the preservation of the limb ought always to be attempted. Our first object, therefore, should be to reduce the dislocation, by bending the leg on the thigh, and making extension and counter-extension from the foot and thigh. Reduction having been effected, and the wound cleansed from dirt and other foreign bodies, the limb must be placed on a hollow splint with a foot-piece, in such a position as admits of the easy application of dressings to the wound without disturbing the joint; then a piece of lint may be laid on the wound, and kept wet by the dropping of cold water from a bottle or other apparatus suspended above it. Should the case proceed favourably, little or no other treatment will be necessary, unless it be the occasional administration of opiates to allay irritation and relieve pain. Some months, however, must elapse before the patient will be able to bear upon the limb; and, however complete the recovery, the movements of the joint are not always restored. It was mentioned just now that, as a general rule, amputation should not be had recourse to in these accidents; nevertheless there are circumstances which justify, and even demand, this operation. Thus, primary amputation may be advisable on account of the advanced age of the patient, or the extensive laceration and contusion of the soft parts, especially if complicated with wounds of the blood-vessels or with extensive shattering of the bones. Amputation may likewise be necessary some time after the accident, when the attempt to save the limb has failed, through diffuse inflammation or sloughing of the soft parts of the foot and leg, or consecutive hæmorrhage, or on account of severe constitutional disturbance threatening the life of the patient.

Dislocations of the Foot at the Calcaneo- and Scapho-astragaloid Joints, commonly called Dislocations of the Astragalus.

In the last-described dislocations the astragalus maintained its normal relations with the other bones of the foot, and altered them only as regards the bones of the leg; in the dislocations we are now about to speak of, the astragalus retains its connexions with the latter, but is no longer in normal relation with the former. Till a comparatively recent date, no distinction was made between this accident and the one next to be described, in which the astragalus is separated from the bones both of the leg and of the foot, but under the general term dislocation of the astragalus were included both these forms of injury. It is not therefore to be wondered at, that those who first recognised the distinction, and perceived that two different accidents had hitherto been confounded with each other, should not have adopted a uniform nomenclature in reference to the newly-discovered injury. Accordingly, it has been described under the following synonyms: (1) dislocation of the astragalus; (2) partial dislocation of the astragalus; (3) single dislocation of the astragalus; (4) dislocation of the head of the astragalus; (5) luxation sous-astragalienne; (6) luxation métatarsienne; (7) dislocation of the scaphoid and calcis from the astragalus; (8) dislocation of the os calcis and astragalus. In adopting a nomenclature which has not hitherto been employed to designate this injury, the writer has been influenced mainly by a desire that it should at once express the real nature of the accident, and at the same time not violate the rule which regards the distal part of the limb as that which is displaced. Both these conditions are more perfectly fulfilled by the title at the head of this section than by any of those antecedently employed. It may be objected, that it is only a part of the foot which is displaced, and therefore to call the accident a dislocation of the foot is not correct; but for this objection to be valid, it must first be shown that the foot deprived of a toe, or the hand of a finger, is thereby disentitled to its distinctive appellation.

The principal varieties of this dislocation are four in number, viz. two lateral, which are the most common; one backwards, which is very uncommon; and another forwards, which is still more rare. The chief lesions which are found in the simple dislocations are rupture, partial or complete, of the interosseous ligament between the os calcis and astragalus, and of the synovial capsules between these bones. The scapho-astragaloid ligament is also torn through, together with the lateral ligaments of the ankle-joint, sometimes on both sides, but more frequently on the one which is opposed to the direction of the displacement. Partial fractures of the astragalus, os calcis, or both bones, or of one or other malleoli, injury or rupture of some of the tendons, blood-vessels, or nerves, are occasionally met with in the compound varieties of this accident.

A question of some interest in connexion with these displacements is, whether the scaphoid, with the rest of the foot, can be luxated from the head of the astragalus, the body of this bone retaining its connexions with the os calcis through the unruptured interosseous ligament; or, to make use of the phraseology generally employed, whether the head of the astragalus can be luxated without its body undergoing displacement. Till the publication of M. Broca's memoir,* this form of injury was generally believed in; but that acute Surgeon, arguing from the anatomical relations of the bones of the tarsus, especially those of the os calcis and cuboid, questions the possibility of its occurrence, and proves incontestably that some of the recorded examples were really luxations of the whole foot at the calcaneo-astragaloid joint, with rupture of the interosseous ligament, while others he considers had their origin in errors of diagnosis. Without doubting the frequency of diagnostic errors, most Surgeons will probably be more disposed to admit with Malgaigne as "très-possibles les subluxations sur le scaphoïde signalées par Boyer et Richerand, et même les luxations complètes de la tête de l'astragale avec un déplacement à peine sensible du corps de l'os sur le calcanéum."† Indeed, the possibility of such an injury must now be considered as placed beyond a doubt by a case recorded by Pollock, in which, in a well-marked dislocation of the foot inwards, the interosseous ligament was found to be unruptured.‡

In the dislocation of the foot backwards (commonly called dislocation of the astragalus forwards), the head of the astragalus rests upon the instep, where it forms a tumour, projecting almost through the skin. The foot is somewhat extended and shortened in front of the leg, but elongated behind. Slight flexion and extension can be made, though attended with pain.

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* *Mémoires de la Société de Chirurgie*, tom. iii. p. 566.

† Op. cit. tom. ii. p. 1031.

‡ *Med.-Chir. Trans.* vol. xlii. p. 39.

Perhaps the best example of this variety of dislocation is that published by Macdonnell, of which the following is an abstract: On the 6th of August 1838, Mr. Carmichael was riding at a brisk trot, when his horse suddenly fell. To prevent being pitched forwards, he threw himself back in the saddle, and strongly extended his legs to meet the ground. The shock of his descent was accordingly received upon the anterior extremities of the metatarsal bones, especially the metatarsal bone of the great toe of the right foot, which alone came to the ground. The following were the symptoms: "The toes were turned outwards, the inner edge of the foot forming an angle of about 30° with its natural direction; the sole was slightly turned outwards, and the outer edge slightly elevated. The concavity of the tendo Achillis posteriorly was manifestly increased, and the heel lengthened. On grasping the soft parts between the tendo Achillis and tibia, we found the distance between these parts much greater than in the other foot. The absence of the hard projection, which would have been formed by the upper articulating surface of the astragalus, had it passed backwards with the other tarsal bones, was evident. The malleoli were perfectly defined. Below and before the inner there was a hard prominence, over which the skin was tense, formed by the inner surface of the astragalus brought into relief by the dislocation, and the slight eversion of the sole of the foot. Much the most striking part of the deformity consisted in a prominence on the dorsum of the foot. Immediately in front of the tibia it presented a flat surface broad enough to receive the finger, and from which there was an abrupt descent upon the anterior part of the tarsus. Over this projection, caused by the head of the astragalus, the integuments were so tense that it was evident a very small additional force would have driven it through the skin. Lastly, on taking the distance from the point of the internal malleolus to the extremity of the great toe with a tape-measure, I found it to be nearly exactly an inch less than the distance between the same points in the left foot. We could detect no fracture. The foot could be flexed and extended, but it occasioned great pain."*

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* *Dublin Journal*, 1839, vol. xiv. p. 235.

Reduction was attempted by making extension from the foot, and counter-extension from the knee, previously bent to the utmost; at the same time the heel was pressed forwards, and the astragalus and tibia backwards, the toes drawn inwards, and the outer edge of the foot depressed. These means failing, pulleys were applied, and the manipulation continued, and in about ten minutes, the pain having become unendurable, Mr. Carmichael made a violent effort, the pulleys were relaxed, and the reduction was effected at the same moment without noise.

Dislocation of the foot forwards is exceedingly rare. Malgaigne could find but one example, which is recorded by M. Parise.* It happened to a quarryman who, while at work, with his left foot resting on a block of stone, and his right on the ground, was thrown forcibly forwards by the falling of a mass of stone; the thigh being at the time strongly flexed on the trunk, the leg on the thigh, and the foot on the leg. The following were the symptoms: the foot was flexed on the leg; the projection of the heel had disappeared; and the extremities of the bones of the leg, with the astragalus, were directed to the posterior part of the calcaneum. As no crepitus could be elicited, the accident was presumed to be a dislocation; but the swelling and pain were so great, that a complete examination could not be made, and reduction was not attempted. Nine months afterwards the condition of the limb was as follows: the foot was flexed at a right angle with the leg, its point inclined inwards, and its inner border slightly depressed; it was elongated in front of the bones of the leg, and the projection of the heel was completely effaced. At the level of, and a little below the malleoli, posteriorly, was a bony projection, which pushed backwards the tendo Achillis beyond the heel. Above this projection there was another less marked, formed by the posterior and inferior margin of the tibia; the malleoli were not separated from each other, nor did they present any traces of fracture. The extensor tendons of the toes were stretched over the instep, and beneath these on the outer side was a projection, which appeared to be the head of the astragalus, and immediately in front of this a depression. Flexion and extension of the ankle-joint existed to a limited extent.

Dislocation of the foot sideways. The lateral dislocations of the foot at the calcaneo-astragaloid joint are most frequently compound and incomplete; that is, the astragalus still rests on a portion of the os calcis, and is not placed at its side as in the complete dislocations. These dislocations are most frequently brought about by forced movements of adduction or abduction, and the foot retains very nearly the position in which it was thrown by the accident; but in some cases it has been forced from under the astragalus without any deviation of its borders or surfaces, as happened in a case reported by Mr. Hancock.* The symptoms of a luxation outwards are, abduction of the foot, its outer border being raised, and its inner resting on the ground. The outer malleolus is buried in the fossa caused by the eversion of the foot, and the inner malleolus and the head of the astragalus project unnaturally inwards. In the complete dislocation this projection will be greater, and, in addition to these symptoms, there will be a shortening of the limb, and the extremity of the inner malleolus will be placed nearer to the sole of the foot. In thirteen examples of this injury collected by Broca, nine were compound, and in six the fibula was broken.

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* *Annales de la Chirurgie,* 1845, tom. xiv.

In the dislocation inwards, the foot is inverted and its inner border raised, resembling the varus form of club-foot. The head of the astragalus and the outer malleolus project beyond the outer border of the foot, and a deep depression exists below. On the inner side of the foot an elongated projection, formed by the inner border of the calcaneum, completely masks the inner malleolus. The scaphoid bone can be felt nearer to the os calcis than natural, and thus the inner border of the foot is shortened and somewhat concave, while the outer is lengthened and unnaturally convex. The tibia and fibula are unbroken.

Two cases of this dislocation have been described by M. Letenneur,† and two by M. Malgaigne.‡

Diagnosis. There are several injuries with which dislocations of the foot at the calcaneo-astragaloid joint may be confounded, the principal of which are the following:

1. Dislocations at the ankle-joint.
2. Fractures of the tibia just above the ankle-joint.
3. Fractures of the astragalus in a horizontal or oblique direction.
4. Dislocations of the astragalus properly so called.

1. From the lateral dislocations of the foot at the ankle-joint they may be distinguished by the projection of the head of the astragalus in front of the bones of the leg, and by the persistence of the movements of flexion and extension; while fracture of the malleoli, which

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* *Lancet*, 1844, vol. ii. pp. 35, 70.

† *Rev. Méd.-Chir.* 1854, t. xii. p. 19.

‡ Malgaigne, op. cit. tom. ii. p. 1044.

is the rule in dislocations at the ankle, is the exception in the corresponding sub-astragaloid dislocations. In the antero-posterior luxations at the ankle, the upper pulley-like surface of the astragalus will project either in front of or behind the leg-bones, and the whole limb will be shortened; while both these signs will be absent in the sub-astragaloid dislocations. 2. Fractures of the tibia just above the ankle-joint, with displacement of the foot backwards, also bear some resemblance to the sub-astragaloid dislocations of the foot in the same direction, but may be distinguished from them by the same signs as distinguished the luxation without fracture just given, and by the existence of crepitus; to which we may add that the dislocation consequent on fracture is rarely or never complete, and the lower sharp ridge of the broken bone can be felt projecting beneath the skin. 3. Fractures of the astragalus, when occurring in a horizontal or oblique direction, are generally accompanied with distortion, resembling somewhat the dislocations we are treating of; the foot with the lower fragment of the astragalus being carried in one direction, and the leg with the upper fragment in the opposite. These accidents, however, are rare, and, in all the recorded examples met with, were compound; so that the nature of the lesion was manifest; but in a simple fracture of this nature, the diagnosis might probably be established by the crepitation, and by the absence of the projection caused by the head of the astragalus. 4. Luxations of the astragalus from all its connexions are unquestionably the accidents which have been most frequently confounded with the sub-astragaloid dislocations; but the shortening of the leg, produced by the approximation of the tibia to the os calcis, the relation of the head of the astragalus to the malleoli, and the loss of motion at the ankle-joint, are sufficient to distinguish them.

Treatment. What cannot fail to have struck any one who has looked over the published cases of this dislocation, and that of the astragalus with which it has been confounded, is the ease with which some of these have been reduced, and the extreme difficulty, and even impossibility, of effecting the reduction of others. These differences are probably owing, in part, to the degree and direction of the displacement; in part, to the amount of intelligence brought to bear on the attempts at reduction; but chiefly, to the presence or absence of certain mechanical impediments. In the dislocation backwards, the posterior edge of the astragalus may become wedged in the fossa between the articulating facets of the os calcis. This has happened in several instances, and has hitherto presented an insuperable obstacle to reduction: thus in M. Roux's case of dislocation outwards, in which amputation was performed, Nélaton found the head of the astragalus resting on the inner surface of the scaphoid bone, while the deep fissure between its two inferior articulating surfaces received a portion of the sharp margin which surrounds the articulating cavity on the posterior surface of the scaphoid; the posterior edge of the astragalus was also engaged in the fossa which separates the two superior facets of the calcaneum.* In the dislocation outwards a mechanical impediment of another kind is sometimes encountered: the head of the astragalus is driven against the tendon of the tibialis posticus muscle, and either ruptures it, or escapes above or below it. In the last case, the neck of this bone will be firmly constricted between the tendon and the calcaneo-scaphoid ligament; and extension made to reduce this form of dislocation will be the most effectual means of preventing it from taking place. In the dislocation inwards the head of the astragalus will rupture or push before it the extensor tendons on the dorsum of the foot, and no obstacle will be presented by them to the reduction; but the scaphoid and anterior part of the foot are drawn towards the heel, so that the space between the scaphoid and os calcis, occupied normally by the under and inner part of the head of the astragalus, is obliterated by the action of the same muscles as are engaged in the production of talipes varus; chiefly the gastrocnemius and soleus, and the two tibial muscles. The dislocation forwards is so rare that no dissections, I believe, have been made to show what were the impediments to reduction; but looking at the form of the os calcis, it would seem that in addition to the muscular resistance, which plays so important a part in all of these dislocations, there may be a mechanical one, arising from the outer border of the posterior facet of the calcis being engaged in the interarticular fossa on the under-surface of the astragalus. With our present knowledge, then, of the chief circumstances which have hitherto so frequently baffled the best attempts to effect reduction of these dislocations, it would seem expedient in all cases of simple luxation, which have not yielded to moderate extension and manipulation, to divide subcutaneously one or more of the tendons of those muscles which offer the greatest resistance to our efforts. In all, reduction would probably be facilitated by division of the tendo Achillis, and in the lateral displacements one or both tibials may also require division.† If these means fail, all further operative measures should be abandoned for the moment, and only again had recourse to if the integuments slough, and the exposed astragalus becomes necrosed, when a part or the whole of this bone may be removed with very little risk to the patient. In the dislocations, compound from the beginning, reduction should be attempted, as in the simple forms; but in the event of failure, the astragalus should be removed without delay.

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* *Bull. de la Soc. Anat.* 1835, tom. x. p. 38.

† See Pollock, *Med.-Chir. Trans.* vol. xlii.

Dislocations of the Astragalus properly so called.

These are the dislocations to which Boyer has applied the term double, on account of the separation of the astragalus from both the tibia and os calcis. According to Malgaigne, these are more common than the sub-astragaloid dislocations, while Pollock believes them to be the most rare of all dislocations implicating the bone. Unfortunately we do not at present possess sufficiently reliable data on which to determine their relative frequency. The astragalus may be displaced in the same directions as it occupied in the last-described luxations, viz. forwards, backwards, and laterally; to which must be added certain peculiar and rare displacements of the bone, in which it becomes rotated, to a greater or less extent, on one or other of its axes. Thus it has been found rotated from a quarter to half a revolution on its antero-posterior or long axis, so as to bring the upper and lower surfaces of the bone to look sideways, or even completely to reverse their normal position; it has also been found rotated around its vertical axis, the head of the bone looking inwards, and the outer surface of its body forwards. Or, more remarkable still, these two forms of luxation have been combined, as in a case related by Thierry, in which the head of the bone was directed backwards, and the posterior extremity of the bone forwards and outwards. At the same time it was so rotated on its antero-posterior axis that the trochlea looked inwards, and the tibia rested on the inner side of its body, which was upwards, its inner edge fitting exactly into the angle formed by the malleolus with the rest of the mortise. Examples of these forms of injury have been recorded by Laumonier (*Journal de Fourcroy*, 1791, tom. ii. p. 40); Foucher (*Revue Méd.-Chir.* 1845, tom. xvii. p. 203); Dupuytren (*Annuaire Méd.-Chir. des Hôpitaux de Paris*, 1819, p. 28); Turner (*Transact. Provin. Med. and Surg. Assoc.* vol. ix. p. 417).

Dislocation of the astragalus forwards. In this form of displacement the astragalus is thrown either directly forwards, or, what is more common, with an inclination of its head to the inner or outer side. The symptoms do not differ as regards the position of the astragalus with reference to the other bones of the foot from those which characterise the dislocations described in the last section, but the relation of the displaced bone to the bones of the leg offers an important point of difference by which they may be distinguished. Thus, the astragalus being thrown forwards from underneath the tibia, forms a projection in front of it; while the latter, now resting on the os calcis, appears sunk into the dorsum of the foot, and the movements of the ankle-joint are of course annihilated. In some of these dislocations forwards, the head of the astragalus has been thrown so much inwards and downwards as to bring the long axis of the bone into a line with that of the tibia, and so to appear as if it were a continuation of that bone. The position of the foot is always found to vary with that of the astragalus, and to be more or less everted or inverted, according as the bone is thrown towards one or the other side.

Dislocation of the astragalus backwards is a somewhat rare accident, but two excellent examples of it have been published by Mr. Benjamin Phillips, in the *Medical Gazette* of 1834, vol. xiv., one of which is here transcribed. "Mr. G. was driving out in a phaeton, when the horse became unmanageable, and the reins broke. Mr. G. threw himself from the carriage, with the intention of stopping the horse; he alighted upon his feet, but immediately fell forward to the ground. The kind of injury which had occurred was immediately apparent by the remarkable projection which was presented just above the heel. The tendo Achillis was pressed out by the displaced astragalus, so as to form an angle of 40°, and at one point the bone had reached so near to the surface that vesication was produced directly over it. The anterior part of the foot appeared shortened, and a projection was presented anteriorly by the inferior extremity of the tibia. There was very little ecchymosis, and it was not at all evident upon what portion of the foot he had rested on coming to the ground. It appeared probable that the foot was suddenly and forcibly flexed, because in that movement the anterior border of the articular surface of the tibia meets the neck of the astragalus, which arrests the movement of flexion before it has proceeded far enough to produce luxation of the foot upon the leg." This conjecture of Mr. Phillips is rendered highly probable by the mode in which the luxation was produced in another case, which he describes in the same journal. The gentleman was playing at cricket, and, while running very rapidly after the ball, a gutter which was in his course was not observed. The toes rested on the further side of this gutter, while the heel was jammed directly into it, and he fell forward. The appearance of the limb in these two cases was very similar.

The dislocated astragalus, instead of being thrown directly backwards, is sometimes found on the inner or outer side of the tendo Achillis, between this and one or other of the malleoli. An example of the displacement backwards and inwards, which was reduced, occurred at University College Hospital, in the year 1839, and is reported in the July number of the *Lancet* of that year. A compound dislocation of the astragalus, backwards and outwards, which could not be reduced, and in which the bone was therefore extracted, is recorded by Turner, in his collection of cases.*

Dislocations of the astragalus, inwards and outwards. These displacements cannot be complete without being at the same time compound, when the nature of the injury is thus rendered manifest. Even in the incomplete luxations, if the bone be not reduced, sloughing of the soft parts over the projecting astragalus takes place subsequently, and reveals the nature of the displacement. It is difficult to imagine how either of these luxations can take place without a fracture of the malleoli; yet Boyer assures us, that in a case of dislocation of the astragalus inwards, to which he was called, there was no fracture of any bone, nor any separation of the tibia from the fibula. On reading his description of the case, it would appear to be a dislocation of the foot outwards, at the calcaneo-astragaloid joint, while at the same time the astragalus was rotated on its long axis, so as to place its upper or trochlear surface inwards, and its outer surface upwards. Thus it can scarcely be called a dislocation inwards, inasmuch as the bone did not completely leave the mortise which is formed for it by the tibia and the fibula. Two other very similar cases have been recorded by Aubray† and Robert,‡ in both of which the bone had undergone the same rotation on its axis; but the displacement inwards was greater, the trochlear surface projecting in this direction beyond the inner malleolus.

Treatment. The reduction of a complete dislocation of the astragalus, without division of some of the tendons which pass from the leg to the foot, would appear at first sight to be well-nigh impossible; and though several such cases have been published, it is highly probable that some of them at least were instances of partial and not of complete luxation. This difficulty of reduction is owing to the obliteration of the space normally occupied by the astragalus, through the action of the powerful muscles which pass from the thigh and leg to the foot; our object, then, must be to reduce to a minimum the muscular resistance, previous to making any attempt to replace the bone. This will be best accomplished by the administration of chloroform, and, if necessary, division of the tendo Achillis. If moderate extension and counter-extension together with manipulation now fail, the bone had better be left in its abnormal situation, and no immediate attempts made to remove it. The propriety of leaving the bone, instead of removing it in the first instance, was strongly insisted on by Sir A. Cooper; and the judiciousness of this practice has been fully proved by the more recent researches of M. Broca, who has shown that in 36 cases of irreducible simple luxation of the astragalus, in which immediate extraction of the bone was performed, 9, or one-quarter, were fatal; while in 43 irreducible cases in which no primary operation was performed, there were only 2 deaths. Of the remaining 41 cases, amputation was performed in 2; and extraction of the bone, after it had become exposed by the sloughing of the integuments, in 16; all of which recovered: while no operation of any kind was required in 23, the patients recovering with a useful limb, though of course with some deformity and lameness.* The practice to be pursued in compound luxations of the astragalus differs from that recommended in the compound sub-astragaloid dislocations, for the reason that the bone is more completely separated from its connexions, and that the space which it naturally occupies is obliterated by the approximation of the tibia and the calcis. The first would render it more liable to death, and the second would increase the difficulty of returning it. If we add to these two circumstances the fact of there being an open wound communicating with the isolated and detached bone, it seems more than probable that, even if reduction were effected, its vitality would be so far impaired as to render its subsequent extraction necessary, while the irritation it would be likely to set up might jeopardise the limb, or even the life of the patient. Under these circumstances, the most proper and safe course is to remove the bone in the first instance, without making any attempt at reduction.

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* Loc. cit. † Aubray, *Journ. de Méd.* 1771, tom. xxxvi. p. 351.

‡ Robert, *Gazette des Hôpitaux*, 1846, p. 381.

Dislocation of some of the other Tarsal Bones.

Dislocation of os calcis, &c. M. Broca, after a careful analysis of the recorded cases of this dislocation, decides that the evidence in favour of them is not conclusive. Malgaigne agrees with Broca, so far as the cases he has adduced as evidence are concerned, yet cites two instances which came under the charge of M. Jourdan at the Hôtel Dieu of Marseilles, which, he considers, establish beyond doubt the possibility of this accident taking place. In one of these the relations of the astragalus, scaphoid, and leg bones, and the movements of flexion and extension of the foot, were perfect. The os calcis projected considerably beneath and external to the outer malleolus, and its anterior articular process was separated from the cuboid. The luxation was caused by a heavy piece of wood falling on the foot from a height; and M. Jourdan easily reduced it by making pressure on the foot and os calcis in opposite directions.* In 1847 Mr. Canton published in the *Lancet* of May 15th "An account of the dissection of an unusual form of displacement of the astragalus," but which Malgaigne considers an example of dislocation of the calcaneum outwards. Dislocations of some of the other tarsal bones are occasionally met with; thus Burnett has described, in the *Medical Gazette* for 1837, vol. xix. p. 221, the case of a gentleman who, in taking a leap while fox-hunting, dislocated the scaphoid bone from its connexions with the cuneiform bones. Burnett found a wound three inches in length over the instep, through which the scaphoid and astragalus protruded, the three facets of the former bone being directed forwards and outwards. By making steady pressure on this bone for fifteen minutes it was reduced, the wound healed, and the patient recovered the free use of the foot. Cases have been recorded by Piedagnel, Walker, and others, in which the bone has been separated from the astragalus as well as from the cuneiform bones.†

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* *Gazette des Hôpitaux*, 1852, p. 371.

Dislocations of the cuneiform bones. Two forms of luxation of the internal cuneiform bone have been met with; in one it is separated from the scaphoid in company with the first metatarsal bone; in the other it is separated from all its articulations, and is thrown upwards and inwards. The three bones are also sometimes luxated together upwards, and are reduced by pressure without much difficulty.

Dislocations of the first row of tarsal bones from the second row, or of the os calcis and astragalus from the cuboid and scaphoid bones. The reality of this accident is somewhat problematical, and has not yet been verified by dissection. Its assumed existence rests chiefly on the evidence of Petit and Sir A. Cooper; the first of whom affirms that he had met with two cases, but gives no description of the symptoms, and merely contents himself with the following brief remark: "Cette maladie se connaît par la seule difformité, elle indique le côté où les os se trouvent logés."* Sir A. Cooper does not profess to have seen the case he describes, which is given on the authority of the students of Guy's Hospital, who had reduced the displacement before he saw it. The description is most meagre and unsatisfactory. "The calcis and astragalus remained," we are told, "in their natural situations, but the fore-part of the foot was turned inwards upon these bones. The appearance was so precisely like that of a club-foot that they could not at first believe that it was not a natural defect of the kind."† Another example of this injury has been recorded by Liston.‡ A boy, aged 14, fell from a height of forty feet, and alighted on the extremity of the right foot. The scaphoid and cuboid bones, it is stated, were dislocated upwards, and the foot was half an inch shorter than the other. Reduction was not attempted, but the patient left the hospital in three weeks able to stand on the foot.

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* Malgaigne, tom. ii. p. 1069.

† *Journal Univ. et Hebdom.* 1831, tom. ii. p. 208; *The Medical Examiner*, 1851, p. 203.

Dislocations of the Metatarsal Bones.

One or more of these bones are sometimes displaced, or the entire range may be thrown upwards, downwards, outwards, or inwards, the first direction being the most frequent. Some rare examples have been seen in which contiguous bones have been thrown in opposite directions; the three first, for example, being thrown downwards, and the fourth upwards. Although these dislocations can only be occasioned by great violence, they are rarely compound; they are most frequently caused by falls on the toes, or force directed on the anterior part of the foot from above downwards, or laterally. The luxations upwards and downwards are readily diagnosed by the shortening of the foot, without a corresponding elongation of the heel, and by the projection and depression on the instep. Mr. Smith of Dublin, who has given one of the best accounts of the upward dislocation of these bones,§ calls attention to the peculiar alteration in the form of the sole of the foot, which, instead of presenting its natural concavity, becomes convex both in its antero-posterior and transverse diameters. The lateral displacements are readily distinguished by the projection at the inner or the outer border of the foot. In recent cases reduction has usually been accomplished by traction combined with manipulation.

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* Petit, *Maladies des Os*, 1723, tom. i. p. 321.

† Cooper, op. cit. p. 336.

‡ Liston, *Practical Surgery*, p. 140.

§ Smith, op. cit. p. 226.

Dislocations of the phalanges are rare. Of twenty-two cases in which the first row were dislocated, Malgaigne states that nineteen were of the great toe, and three of all the toes at once. The displacements are always upwards, and may be complete or partial, and are generally compound. There is a certain analogy between the luxation of the first phalanx of the great toe and that of the corresponding phalanx of the thumb, and a similar difficulty is experienced in its reduction; this, it has been conjectured, is owing to the resistance of the internal lateral ligaments and the tendons of the short and long flexor muscles. Reduction has sometimes been effected by traction only, but at other times all means, even dividing the internal lateral ligaments and the flexor tendons, have failed. Dislocations of the second row of phalanges are so rare that Malgaigne could find but two examples of the accident on record; one was a compound dislocation affecting the great-toe, and the other the third toe; both were returned. These accidents, he states, are almost peculiar to jockeys, and arise from falls from horseback with the foot underneath the animal. They have also been occasioned by the passage of carriage-wheels over the foot.

CARSTEN HOLTHOUSE.

DISEASES OF THE EYE.

CHAPTER I.

DISEASES OF THE CONJUNCTIVA AND SUBJACENT AREOLAR TISSUE.

(*Ophthalmia; Conjunctivitis.*)

INFLAMMATION of the conjunctiva, I need hardly say, accompanies many of the inflammatory processes originating in other tissues of the eyeball. In the present chapter I confine myself to those cases in which the inflammation originates in the conjunctiva, and is either limited to it, or spreads only to the sclerotic.

Inflammatory redness differs very remarkably in these two structures. It is on the inner surface of the lids, and at their point of junction with the globe, that the conjunctival vessels are largest, and their redness is most strongly marked; and the colour becomes paler as the vessels diminish in size on approaching the cornea. The sclerotic vessels, on the contrary, are most visible close to the cornea, around which they form a pink circle, known as the *sclerotic zone*,—a very characteristic mark of several important forms of disease in the deep-seated tissues of the eye. Even if the sclerotic be uniformly injected throughout its whole extent, this injection cannot be traced very far back from the edge of the cornea, because the redness soon becomes hidden beneath the fibrous expansion of the recti muscles. The vessels of the sclerotic are small, closely set together, and so interlaced with the proper fibres of the part that the individual trunks cannot be recognised; they merely produce the effect of a uniform tint of colour, nearly resembling that of carmine. The conjunctival vessels, for the most part, are plainly seen, and, except in that high stage of inflammation termed *chemosis*, they can be observed repeatedly to anastomose, so as to form a closely-set network.

Elaborate classifications of the various forms of ophthalmia are to be found in many of the systematic works on eye-diseases; but minute distinctions, however plausible they may look on paper, are of little or no use to the practitioner. In selecting a few heads, under which to group the varieties of ophthalmia, I have been guided by the very decided peculiarities which certain forms present, or by the marked difference in the treatment they require. Most of the slighter forms of conjunctival redness, not resulting from direct violence or the presence of foreign bodies, are due to atmospheric changes; and the cases described by authors under the name *simple ophthalmia*, are, for the most part, mild cases of catarrhal inflammation. When the sclerotic also is affected, the term *rheumatic* is sometimes added; and Mackenzie uses the words "catarrho-rheumatic" to signify that both the conjunctiva and the sclerotic are inflamed, although the inflammation may be due to the mere external agency of cold, and not to the presence of rheumatic poison in the blood of the patient.

Slight attacks of redness of the conjunctiva are commonly attended with only trifling uneasiness. The enlarged vessels, projecting above the level of the membrane, suggest to the patient the notion of foreign bodies, sand or dust, between the lids and the globe. But in other instances, where the redness is very trifling, the pain is of a neuralgic character, and it is for the irritation existing in the ophthalmic division of the fifth nerve that the patient seeks medical aid. It is important for the young practitioner to remember that in such cases the suffering may be really severe, although there is far less appearance of inflammation than in other cases where pain can hardly be said to exist.

Whenever a case of ophthalmia is seen for the first time, the margins of the lids and the puncta lacrymalia should be carefully explored, as a few irregular eyelashes, or even a single eyelash lodged in one of the puncta, may be causing the irritation.

It sometimes happens that a foreign body, lodged under the upper lid, sets up a considerable amount of ophthalmia, and yet the patient is not aware of any such cause of irritation being present. To evert the lid requires a certain amount of tact and practice. A probe, or the feather-end of a pen, just thick enough to resist bending, is to be laid horizontally across the lid, about half an inch from its free margin. The Surgeon then grasps with his finger and thumb the eyelashes growing from the middle of the tarsus, and draws the lid away from the globe, while at the same moment he slightly depresses the probe or pen, and tells the patient to look downwards. The tarsal cartilage tilts over, and the conjunctival surface of the lid is exposed to view. The foreign body is almost invariably found within a line or two of the tarsal margin.

This simple eversion of the lid appears so obvious a method of detecting foreign bodies, that one fancies it must have suggested itself to Surgeons from the very earliest period; and yet, as far as I can discover, it was for the first time made public by Ware, in 1787.*

When the Surgeon has satisfied himself that the redness of the conjunctiva is not caused or kept up by any mechanical irritation, he is not at once to prescribe a lotion or drops as a mere matter of routine. I shall hereafter have occasion to speak of the invaluable properties of a local stimulant in cases of true *catarrhal ophthalmia;* but at present I am considering those varying forms of conjunctival redness which are described by most writers under the name of *simple ophthalmia.* It is the Surgeon's business to note well the general aspect of the patient; to ascertain what is faulty in respect of digestion, general nervous power, condition of the circulation; whether the ophthalmia can be traced to over-use of the eyes, exposure to irritating or vitiated air, want of exercise, excess in the use of stimulants, tobacco, &c.; in short, a rapid survey is to be taken of whatever is faulty in the patient's general health, and, in most cases, when this has been done, and the proper medical and dietetic means have been taken to correct what is amiss, the ophthalmia is already in a fair way of being cured.

As a rule, local congestion of the conjunctival vessels is met with in feeble and languid patients, who require tonics,—iron, or quinine, or mineral acids, and a corresponding plan of diet. Of course there are many cases in which an excess of stimulants, and general over-feeding, have disturbed the due balance of the patient's circulation, and where a restricted and well-regulated diet is absolutely essential. But even in such cases a careful and moderate use of tonics is often necessary. What I wish to guard my readers against is the habit, which has been handed down to us from early times, of regarding all inflammations of the eye as necessarily to be treated by depletion, leeches, and low diet. The very reverse of this is the truth. The popular notion that a leech or two to the temples, and a purgative, must needs cut short an attack of inflammation in the eye is shared by only too many of the old school of practitioners. In young children especially such treatment is most mischievous. From the age of one or two years up to puberty, ulceration of the cornea is what we have most to fear, and this is sometimes attended with so slight a degree of redness of the conjunctiva and sclerotic, that it is important for the Surgeon to be aware of this fact, and not to overlook slight attacks of ophthalmia in such subjects, but in every case to look carefully to the condition of the cornea.

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* *Remarks on the Ophthalmy,* &c. p. 23.

While I so strongly insist on the great importance of general treatment in ophthalmia, I by no means exclude the use of local remedies. Where much intolerance of light exists, a small blister to the temple, or the application of tincture of iodine to the skin of the upper lid, will often afford great and immediate relief. Bathing the eyes night and morning with warm water is of great use in some irritable patients; while, in other cases, the use of cold water is indicated. Those persons especially who have induced a congested state of the conjunctival vessels by prolonged exposure to artificial light are often greatly relieved by a plentiful sluicing of the closed lids with cold water night and morning. Where there is agglutination of the lids during sleep, a little spermaceti, or perfectly fresh olive-oil, may be smeared on the eyelashes at bedtime. Weak solutions of acetate of lead or alum (two or three grains to an ounce of distilled water) are useful in chronic cases; but they should be used sparingly, and never for too long a time. After a few days they should be left off, and the part allowed to recover its natural tone, the stimulant being resumed if necessary; but it should never be uninterruptedly continued for weeks or even months, as patients are only too fond of doing.

There are certain forms of ophthalmia which present such distinctive characteristics that they are very properly known by special names. Such are the *Catarrhal*, the *Purulent* (including the *Infantile* and the *Gonorrhœal* forms), the *Pustular*, and the *Chronic*. The disease commonly termed *Scrofulous Ophthalmia* should rather be classed among the diseases of the cornea; and the same may be said of the *Exanthematous* ophthalmia of authors, for it is the cornea which chiefly suffers, either by ulceration or sloughing, in consequence of the low state of vitality following the various forms of exanthematous disease. The term chronic, although of course applicable to any slow and protracted form of disease, when applied to ophthalmia is usually understood to mean an affection of the palpebral conjunctiva, the caruncle and semilunar fold, and the margin of the lids, which is either developed as an independent disease, or remains as a sequela of an acute attack of catarrhal or purulent inflammation.

CATARRHAL OPHTHALMIA.

This is commonly caused by exposure to draughts of cold air, but it is by no means limited to the cold season of the year. It frequently attacks large numbers of persons during the extreme heat of July or August, especially if an east wind prevails at the same time, as is often the case.

A well-marked case of catarrhal ophthalmia presents the following appearances: the cornea is quite clear, and vision is unimpaired, or only occasionally obstructed by the passage of thickened mucus across the area of the pupil. The conjunctiva of the lids is redder than natural, and the injection is particularly marked at the point of reflection of the conjunctiva from the lower lid to the globe. The semilunar fold and caruncle are red and much swollen, particularly the former, and this enlargement of the semilunar fold often remains long after all other traces of the ophthalmia have subsided. The surface of the globe presents a network of vessels which gradually becomes less marked as it approaches the cornea. In some cases the sclerotic is involved, and then the peculiar pink zone is seen reaching close up to the margin of the cornea.

A peculiar characteristic of true catarrhal ophthalmia is the existence of numerous red blotches at various parts of the network of vessels, caused by some of these having given way and allowed their blood to become extravasated. The extravasations vary much in size; some are as small as a pin's head, others almost equal the breadth of the cornea.

At the commencement of the attack there is little increase of secretion; subsequently, mucous secretion sets in, which in some cases become so profuse as to make the Surgeon suspect that the case may be one of true purulent ophthalmia.

There is usually no acute pain in common catarrhal inflammation; but a sense of weight and stiffness in the lids, and, as the disease advances, the enlargement of the vessels suggests to the patient the notion of sand or some other foreign substance between the lids and the globe.

When the sclerotic is much involved, there is usually intolerance of light, and much secretion of tears, and pain either of a dull aching or of an acute darting character. The upper lid, too, frequently becomes œdematous in cases of this mixed kind of sclerotic and conjunctival inflammation, and the infiltration of the subconjunctival cellular tissue raises the conjunctiva above the level of the cornea, so as even sometimes to overlap its margin. This elevated condition of the inflamed conjunctiva is termed *Chemosis*.

I need hardly say that a patient who is the subject of catarrhal ophthalmia is frequently disordered in general health, with confined bowels and disturbed digestive functions, and may require appropriate treatment by internal medicines; but very frequently the ophthalmia comes on without any general ailment, and seems a purely local affection, even limiting itself in some instances to one eye.

Treatment. When the ophthalmia is unattended with constitutional disturbance, and is confined to the conjunctiva, the local application of nitrate of silver in solution may be regarded almost as a specific. It should be used in the proportion of two grains to the ounce of distilled water, and dropped upon the surface of the eye twice or thrice a day, the conjunctiva being cleansed, by bathing it with warm water, before each application of the drops. At bedtime the eyelashes should be anointed with a little spermaceti-ointment or olive-oil. Care must be taken not to continue the use of the drops too long. After being used for a week, they may be omitted for a couple of days, and then resumed as before, if the inflammation appears unsubdued; but often it will be sufficient, after a week's application as above described, to use the drops for a few days longer once a day. In uncomplicated cases, ten days or a fortnight will suffice for the cure; but, if the disease spreads to the sclerotic and cornea, the nitrate of silver must be omitted, and the case treated on the principles laid down in Chapter II. The caruncle and semilunar fold are the last to recover their healthy condition after an attack of catarrhal ophthalmia. I have said that the treatment by nitrate of silver is to be adopted when the inflammation is *limited to the conjunctiva;* and it is from want of attention to this point that so much mischief is constantly done. Whenever the sclerotic is much inflamed, and, still more, whenever the cornea is in the least degree implicated, nitrate of silver does nothing but harm.

PUSTULAR OPHTHALMIA.

This is a very common form of ophthalmia, especially among children and young persons. It is characterised by little, reddish, aphtha-like elevations on the conjunctiva, each surrounded by a plexus of blood-vessels. The centre of the little elevations is less vascular, and therefore whiter, than the base, and hence their appearance is a good deal like that of a pustule; but they do not contain pus, and the term "papular ophthalmia" would be more appropriate than "pustular." When only one or two of these so-called "pustules" are present, they are usually found upon the equator of the eyeball; but sometimes they are more numerous, and almost surround the cornea. They are seldom attended with much pain, or intolerance of light, unless the sclerotic be also inflamed. In pure pustular ophthalmia the cornea never suffers, although, from the redness extending close up to its margin, patients are often alarmed at the prospect of the disease affecting the sight.

Unless there be some derangement of the general health, the treatment of pustular ophthalmia is very simple. A weak solution of acetate of lead—two, three, or four grains to the ounce of distilled water—may be used twice or thrice a day; or, if the inflammation be extensive, and the "pustules" numerous, a blister to the temple should be applied before the lotion is resorted to.

Purulent Ophthalmia.

(*Suppurative Ophthalmia; Ophthalmo-blenorrhœa; Conjunctivitis puro-mucosa; Ophthalmia contagiosa; Egyptian Ophthalmia; Ophthalmia bellica; Military Ophthalmia.*)

On arriving at the consideration of this form of ophthalmia, we must no longer confine our attention to the conjunctiva; for although it is in this tissue that the disease commences, it derives all its importance from the fact that the *cornea* is liable to become involved. Much has been written upon the essential differences subsisting between the common purulent ophthalmia of adults, that affecting infants, the Egyptian, and the gonorrhœal ophthalmia; but these various forms, in certain stages of their progress, often resemble each other very closely, so that a severe case of common purulent ophthalmia cannot be distinguished from one of gonorrhœal origin; and the purulent secretion from the eye of an infant suffering from *ophthalmia neonatorum*, if applied to the eye of an adult, may set up all the phenomena of the truly gonorrhœal form. We must not expect, therefore, to be able in every instance to say with certainty, the first time a patient comes before us, This is simple purulent ophthalmia; or, This is of gonorrhœal origin; we must wait until we have had time to watch the progress of the case.

If a patient presents himself in an early stage of purulent ophthalmia, we may, as I have said, be unable to distinguish the disease from the simple catarrhal form; but should the purulent ophthalmia have reached its height, we should find the following appearances.

The patient is generally pale and depressed; the lids are of a dull red, inclining to purple; they are swollen and œdematous, often to such an extent as to prevent the patient separating their margins in the smallest degree. When the Surgeon draws them apart, thick yellow secretion oozes from the conjunctival surface, and, if allowed to dry, forms a crust, which almost hides the eyelashes from view. The inability to open the eyes very naturally induces the patient to believe that he is blind, and this belief tends still further to depress him both in body and mind. To separate the lids, to cleanse the cornea from the secretion which overspreads it, and thus to give the patient a glimpse of surrounding objects, is often the best means to raise his general powers.

In a case of extreme inflammation, such as I am now describing, the conjunctiva covering the globe is reddened, infiltrated with serum, and raised to a considerable extent above the surface of the sclerotic. This is especially the case immediately around the cornea, the conjunctiva being thrown up into a roll which overlaps the corneal margin. This raised condition of the inflamed conjunctiva constitutes what is termed *chemosis*,—a very characteristic mark in this and other forms of severe inflammation. In exploring the surface of the cornea, the Surgeon should not content himself with merely cleansing it from secretion by means of a bit of wetted lint or sponge; but with a probe or little spatula he should carefully lift up the overlapping portion of the chemosis, in search of any hidden ulcer; for it is at the extreme edge of the cornea that the ulceration sets in, which may eventually go on to perforation.

The milder cases of purulent ophthalmia stop short of the ulcerative stage; and under appropriate treatment the puriform secretion ceases, the conjunctiva gradually loses its unnatural vascularity, and regains its healthy aspect.

The severer cases terminate either in *ulceration* or *slough* of the cornea. The ulceration usually begins, as I have said, at the corneal margin, and as it extends assumes the form of a more or less deep crescentic groove. Then the ulcer perforates the cornea at some point, and a portion of iris prolapses, producing the appearance of a small dark-coloured nodule at the bottom of the ulcer.

Of course any protrusion of the iris must cause deformity of the pupil, which becomes pear-shaped, oval, or reduced to a narrow slit, in proportion to the amount of iris which has escaped through the ulcer. Sometimes the ulceration spreads as a deep groove quite around the margin of the cornea, so as to isolate its central portion, which stands out in relief, cloudy or wholly opaque. Eventually this central portion yields to the ulcerative process, and then the whole cornea becomes thinned, so as to yield to the pressure of the contents of the globe, and forms a bulging mass made up of the remains of the corneal tissue, between the fibres of which dark-coloured portions of exposed iris protrude. At a later period the surface becomes traversed by ramifying blood-vessels. This wholesale destruction of the cornea, however, rarely occurs except in cases of gonorrhœal inflammation. Sometimes purulent ophthalmia, instead of inducing ulceration, ends in *sloughing*. In that case the chemosed conjunctiva encroaches a good deal upon the surface of the cornea; the latter becomes hazy, then opaque and yellowish, and quite dull on the surface; at last it looks almost like a piece of wash-leather, then softens and comes away in shreds, the whole iris bulges forwards, and becomes coated with a fibrous exudation, which eventually transforms the part into a *staphyloma*.

Purulent ophthalmia can undoubtedly be transferred by contact with the secretion from one person to another. Patients, therefore, should be cautioned on this point, as also their nurses or attendants. It seems probable that in hot countries, where this ophthalmia is very prevalent, the flies act as propagators of the disease. The dust also of those countries, by keeping the conjunctiva in a state of chronic irritation, no doubt predisposes to the attack. In England the disease, like the common catarrhal form, is, I think, most frequent during the extreme heat which sometimes visits us in July or August, if it be attended, as is often the case, with an east wind.

Treatment. Although the more rational practice of the present day has effected a vast reform in the treatment of so-called inflammatory diseases, both internal and external, the force of old prejudice and habit has, to a great extent, prevented medical men from applying the same reasoning and common sense to the treatment of eye-diseases which they apply to those of other organs of the body. And, indeed, if a practitioner, unaccustomed to meet with ophthalmic cases, turns in his difficulty to many a work of high authority, published in his own day, he finds such a system of depletion recommended for purulent ophthalmia as is positively frightful.

Purulent ophthalmia, in its severe form, is usually met with in patients who are irritable, pale, and depressed. And this is almost certain to be the case if the disease be seen at an advanced stage; for the popular notion of the disease, and, indeed, of nearly all diseases of the eye, is, that depletion of every kind is the only way to combat them. So true is it, that the vulgar errors of to-day are but the solemn medical dicta of our forefathers.

If the patient's bowels have been well relieved, the first requisite is usually a narcotic at bedtime. I almost always give tincture of hyoscyamus, ♏xxv. or ʒss. or even ʒj. in camphor-mixture, unless the patient has been habituated to the use of opium, when a moderate dose of that drug may be preferable. It is not easy to lay down positive rules for diet, but it should be such as is best calculated to keep the patient's vital powers to the level of ordinary health; as much of plain nutritious food being taken as the stomach can digest, and just such an amount of stimulants as will aid digestion, and maintain the due vigour of the circulation. Quinine is almost always useful in suitable doses. In short, ulceration and sloughing of the cornea should be combated or guarded against, just on the same principles as those destructive processes would be combated in any other tissue of the body. To a delicate, ill-fed, over-worked woman, attacked with acute purulent ophthalmia, it may be necessary, in addition to a little beer at her dinner, to order a glass of wine twice a day. To a person in a comfortable position in life, the ordinary amount of stimulants may be amply sufficient; while, with one habitually intemperate, a considerable diminution of the accustomed quantity may really effect the desired object, by avoiding that after-depression of the nervous system which invariably follows over-indulgence in drink.

The local treatment of purulent ophthalmia consists in the frequent employment of astringents, such as alum, nitrate of silver, or tannin, dissolved in distilled water. The alum may be used in the proportion of eight or ten grains to the ounce, and applied by means of a fine soft rag, every hour during the day, and as often during the night as is compatible with the patient's rest. Where the surface of the globe can be well exposed by drawing down the lower lid, it may suffice to dab the surface of the palpebral conjunctiva, and to squeeze the lotion over the surface of the eye from the rag or a fine sponge. If there be so much swelling of the lids as to make it impossible to expose the surface of the globe, the lotion must be injected beneath the lids with a syringe, first throwing in a little warm water to clear away the discharge. As the case improves, the lotion may be used less frequently, every two or three hours. If nitrate of silver be employed, it should be in the proportion of three or four grains to the ounce, and be dropped upon the surface of the globe three or four times a day, after syringing away the discharge with a little warm water. Tannin dissolved in distilled water may be used as a substitute for the alum. In some severe cases which assume the violence of the gonorrhœal form, ulceration rapidly extends along the edge of the cornea,—usually the lower edge,—in the form of a deep crescentic groove. Unless speedily arrested, it penetrates the thickness of the cornea, and if the opening into the anterior chamber be large, so much of the iris may prolapse as greatly to diminish, or wholly to annihilate the pupillary aperture. In such cases it is sometimes possible to check the spread of the ulcer by rapidly passing over its entire surface a fine point of nitrate of silver. A fine probe, coated with the fused salt, is usually the best means of application.

I need hardly allude to the great importance of pure air in the disease now under our notice. In fine weather it is not necessary, even during the acute stage, wholly to confine the patient to the house; and when the ulceration is arrested, and the purulent discharge has ceased, careful and judicious change of air will tend more than any thing else to remove the chronic ophthalmia, which is otherwise apt to linger on for a long period.

Gonorrhœal Ophthalmia.

This disease is essentially the same in character as the preceding; but is far more severe and destructive. It is caused by gonorrhœal matter coming in contact with the conjunctiva.

I know of no symptom by which we can positively distinguish ordinary purulent ophthalmia from the gonorrhœal form, provided the two diseases are seen at an early stage. Many authors speak of gonorrhœal ophthalmia almost invariably confining itself to one eye; but this is certainly not the case. It so happens that on the very day on which I write these lines I have had a lad of 15 brought to me with both eyes utterly lost from gonorrhœal ophthalmia, after a neglected attack of less than two weeks' duration. Both corneæ had perished, and the irides were laid bare. The lad was still suffering from urethral discharge, contracted about a month ago. I could multiply cases of this kind, in which both eyes were attacked within a few days of each other.

Gonorrhœal, like ordinary purulent ophthalmia, begins with redness of the conjunctiva, and a sensation of sand beneath the lids. After a few hours muco-purulent discharge sets in, and the ocular portion of the conjunctiva becomes infiltrated with serum. This thickening rapidly increases and forms a *chemosis*, which is always a very marked symptom in gonorrhœal cases. At the same time the lids become red, and so much swollen that the patient can separate them to only a very slight extent. The cornea becomes hazy; and at this stage an ulcer is almost certain to be found at its margin. Sometimes ulceration begins while the rest of the cornea is still clear; and in that case some care is necessary to detect the loss of substance. A thorough examination of an eye at this stage of the disease cannot be made without the aid of the wire speculum, which prevents the swollen conjunctiva of the lids from bulging over and hiding the cornea. If the margin of the cornea be overlapped by chemosis, a probe or little spatula should be used to hold it aside, while the surface of the extreme edge of the cornea is wiped perfectly clean with a bit of wetted lint or rag.

Patients affected with gonorrhœal ophthalmia are almost always in a state of depression, with weak pulse and deranged digestion. This condition is partly due to the local disease itself, and partly to the distress of mind caused by the fear of impending blindness. It seems extraordinary that Surgeons of eminence can have been so far misled by theoretical notions about "inflammation" as to have overlooked the general condition of these patients, and to have treated them by frightful bleedings, mercury carried to salivation, and other depressing means. Those of my readers who may imagine that the so-called "antiphlogistic" plan of treating gonorrhœal or severe purulent ophthalmia belongs to the remote past, need only turn to the works of several recent or still-living authorities, to find that profuse bleeding, mercurialism, and a diet just stopping short of actual starvation, are enjoined as the best means of arresting ulceration and sloughing in the eye; while the very same authorities would have condemned, as *mala praxis*, such treatment of similar morbid processes in the arm or in the leg. One author tells us, that "the *only case* of gonorrhœal ophthalmia he had seen in which the eye was saved was that of a young woman, in whom venesection was repeated as often as blood could be got from the arm. She lost 170 ounces of blood in a few days, and looked as if every drop of blood had been drained from her body, the skin having nearly the hue of a wax-candle." One would have thought that the adage, *exceptio probat regulam*, would have occurred to this Surgeon's mind, and that he would have regarded a system as self-condemned under which *only one* eye had escaped destruction. But he never seems to have had the slightest suspicion that the system could be wrong.

A second authority quotes, among other cases, the case of a young man who, on the first day, had been bled to fainting, then vomiting was kept up by tartar-emetic as long as it could be borne. In the evening, the pain in the eye had become worse; he was bled again. On the following morning the swelling of the lids was greatly increased, so that the eye could not be seen, and there was copious yellow discharge; the night had been passed in severe pain, which entirely prevented sleep. Bleeding was repeated twice more; blood was taken, by cupping, from the back of the neck and the temple, and leeches were applied around the eye in large numbers; "but although the free use of purgatives and antimonials, with low diet, was combined with these measures, no sensible effect was produced in diminishing the violence of the inflammation, or arresting its progress." Still no misgiving as to the soundness of the system! A third Surgeon tells us, that "the lancet must be hardly ever out of our reach; for if ever there was a disease in which blood may be taken away without limitation, it is this." A still later authority, writing little more than twenty years ago, says, "You will deem it necessary to bleed at the outset of the attack most freely; it would be almost criminal to stop the flow of blood until your patient exhibited symptoms of faintness; and as soon as he rallies, and the pain returns, the operation should be repeated until syncope is again produced. At the same time you would prescribe a liberal dose of calomel and jalap, so as to act freely on the bowels, and afterwards the tartarised antimony in sufficient quantity to maintain a state of decided nausea. You would also freely scarify the conjunctiva, . . . taking care to divide the texture of the conjunctiva at each sweep of the knife, so as to penetrate as far as the fluid effused into the subconjunctival cellular membrane. Bleeding from the conjunctiva is to be encouraged. A weak alum-lotion is to be used, and the diet is to be limited to 'light fluid aliment.'" An injunction hardly necessary, since one cannot see how a man who has been kept in a state of perpetual nausea is to retain any food at all. But the patient is not to escape with only this amount of depletion. "You would proceed to apply a quantity of leeches just below the tarsal margin of the lower eyelid, and direct the application of a blister between the scapulæ. Lastly, it may be necessary to use tonic and stimulating lotions, . . . and to employ a restorative regimen to reinvigorate the reduced powers"! Powers, be it observed, which have been reduced by the Surgeon himself. We are to pull the house down, and then try to build it up again.

I may be told, that it is useless to bring forward such cases as these; that the current of medical opinion is changed, and that it now sets strongly against bleeding and depletion, and rather towards a tonic and stimulating plan of treating diseases. I am glad to acknowledge that such is the fact; but, by some strange fatality, the arguments which are allowed to apply to other diseases are still, to a great extent, ignored so soon as diseases of the eye come to be treated. Some of the works from which I have quoted are still referred to by those who have only occasional opportunities of seeing cases of gonorrhœal ophthalmia, and I cannot therefore think it superfluous to warn my readers against this system of Sangrado-like depletion.

Even Tyrrell, who in his treatment of other diseases laid so much stress upon supporting the powers of the patient, seems in the instance of gonorrhœal ophthalmia to have followed the track of his predecessors in respect of depletion. He introduced a new method of scarifying the conjunctiva, which he believed to be destined to effect a total change in the treatment of the disease. It was founded upon the theory that the cornea perished by sloughing; that this sloughing was caused by fibrinous effusion beneath the conjunctiva immediately surrounding the cornea, whereby the vessels supplying the cornea were compressed, and their circulation impeded. He assumed that the cornea derived the whole of its nutrition through blood-vessels passing into it from the conjunctiva, and he quite ignored the fact of any vessels passing to it from the sclerotic, and would have utterly repudiated the notion of such a thing as a non-vascular tissue. The elevated roll of conjunctiva, constituting what is called the chemosis, was to him the great source of danger, and this was to be freely divided by means of radiating incisions, so as to allow the effused fibrin to escape, and the vessels supplying the cornea to be relieved from pressure. The anatomical mistake upon which Tyrrell's practice was founded was well exposed at the time by Mr. Wharton Jones.

The fact is, that the cornea, in severe cases of gonorrhœal ophthalmia, does not simply perish by sloughing, in the same way as a tumour strangulated by a ligature perishes. Ulceration first attacks the extreme edge of the cornea, in the manner I have described at page 683, and extends in a crescentic form until a considerable portion of the cornea has been cut off from its nutritive supply, and then of course it loses its vitality. In some cases, I have seen the ulceration extend all round the corneal margin; and then the central isolated portion, having previously become opaque, has rapidly assumed a softened pulpy appearance, and come away in shreds. The chemosis, which has been so much dreaded as the active agent in the destruction of the cornea, is merely formed by the infiltration of serum from the overloaded blood-vessels into the subconjunctival cellular tissue. Of course chemosis is an important symptom whenever it occurs, because it proves a congested condition of the blood-vessels of the conjunctiva, with which there is generally associated a congestion of other more important tissues; but to reduce the patient's vital powers by bleeding, mercury, and low diet, and then to expect to save the cornea by cutting the conjunctiva, appears to me utterly irrational, and opposed to the first principles of physiology and common sense.

In speaking of purulent ophthalmia (page 681) I have anticipated the treatment of the gonorrhœal form. It is quite impossible to lay down positive rules as applicable to all cases. Each case becomes a study in itself, and according to the patient's constitution, habits, station of life, and previous treatment, must the Surgeon modify his plan. To maintain the digestive functions, to administer suitable quantities of nourishment, to sustain the circulation at a proper point of vigour, neither unnaturally exciting it to hurried action, nor allowing it to flag, and so lead to local congestion of blood, and consequent deterioration of tissues,—to secure as far as possible pure air at an equable temperature, to sooth the nervous system, and promote sleep by such mild narcotics as shall not confine the bowels or induce subsequent depression,—such is the outline of the general treatment to be pursued.

The local applications I have already indicated at page 681, only I would lay still greater stress, in cases of gonorrhœal ophthalmia, upon the utility of nitrate of silver, applied in substance to the surface and edges of the crescentic ulcer. Unless this application be made with great care and neatness of hand, it may do more harm than good. A stick of nitrate of silver can hardly be pointed so finely as to answer the purpose, and a fine probe, upon the end of which a small portion of the salt has been fixed by fusion, is to be preferred. The lids being held apart with a wire speculum, and the edge of the cornea having been wiped clean, the fine point of nitrate of silver is to be lightly passed over the whole surface of the ulcer. This application may require to be repeated after a couple of days, but should not be persevered in after the ulceration has ceased to spread.

In spite of all our efforts and care, it must frequently happen that cases of gonorrhœal ophthalmia terminate in loss of sight. For the disease often occurs in unhealthy subjects, weakened by intemperance and debauchery, and who, before they apply to a regular practitioner, have probably been in the hands of quacks, whose only remedy is mercury. Still, when we consider of what immense importance it may be to retain even a small portion of the cornea in a transparent condition—thereby enabling the Surgeon at some future time to make an artificial pupil, and so rescue the patient from blindness,—we ought never to give up a case of gonorrhœal ophthalmia so long as any portion of one cornea retains its vitality.

GRANULAR CONJUNCTIVA.

(*Granular Lids; Trachoma.*)

One of the most serious sequelæ of purulent ophthalmia, whether of the simple or the gonorrhœal form, is that condition of the conjunctiva termed "granular," involving a hazy and vascular state of the cornea. During the progress of purulent ophthalmia, the palpebral conjunctiva, when cleansed from secretion, appears villous; and, after the purulent discharge has ceased, this condition of the membrane goes on increasing, until its surface resembles that of a granulating ulcer. The so-called "granulations," however, are in reality the follicles and papillæ of the conjunctiva, enlarged by inflammatory deposits. The firmness and solidity of these "granulations" vary much in different subjects. When hard, and of considerable size, they cause irritability and blinking of the lids, and lacrymation, and after a time the cornea, especially its upper half, becomes hazy, and is traversed by numerous large vessels, forming, in some cases, a complete network, and giving an almost fleshy aspect to the part (*pannus*).

Treatment. The granulations were long since recognised as causing by their friction the chronic inflammation and vascularity of the cornea; and accordingly, a great variety of plans have at various times been adopted for removing the granulations, and restoring smoothness to the palpebral conjunctiva. Complete excision with the knife or scissors, the rapid action of escharotics, and the more gradual wasting by means of astringents, have all in turn been employed against granular lids.

Effectually to cut away the granulations requires such extensive removal of the palpebral conjunctiva as is likely to induce permanent curving of the tarsus and consequent ectropion; and the same result may follow the free employment of nitrate of silver. The ordinary astringent lotions of alum, tannin, &c. are powerless in the more severe cases. I have seen much benefit from the acetate of lead, applied by dusting it, in fine powder, over the everted lid. This causes a good deal of pain at the time, but afterwards gives decided relief, apparently by mechanically filling up the interstices of the elevations, and so producing a smooth surface for the eyeball to move upon. The salt, as it slowly dissolves, seems also to exert an astringent effect upon the vessels of the enlarged follicles and papillæ, and so to diminish their bulk. But the most effectual means I have ever tried for removing granulations is the undiluted liquor potassæ, applied by dabbing it upon the everted lids, on which it seems to act by chemically saponifying and dissolving away the hypertrophied tissue. The application may be repeated at intervals of a few days; and six or seven weeks of this treatment will sometimes suffice to remove the granulations, and, at the same time, to restore a considerable degree of clearness to the cornea.

But, every now and then, cases are met with in which the cornea is so opaque, and so traversed by large blood-vessels, as to prevent useful vision, even when the granular state of the lids has been almost subdued. Such instances of opaque and vascular cornea follow severe purulent ophthalmia, especially the form so common in the East, and known to us as Egyptian ophthalmia. Cases of almost equal opacity are met with at our London hospitals, among the more destitute Irish patients. It appears that a very severe form of purulent ophthalmia is sometimes epidemic in certain districts of Ireland, rivalling in virulence the disease of tropical countries.*

Patients who have been a long time suffering from granular lids in a severe form are almost invariably out of health; often reduced by the violent courses of medicine they have undergone, and with the eyes in an irritable condition from long-continued use of caustic applications. To place such patients, if possible, in a pure and bracing air, and to improve their general health by suitable tonics, will be the first indications for treatment. Caustics and stimulants should be laid aside, and counter-irritation employed by means of small blisters to the temple, and tincture of iodine to the skin of the lids. In this way considerable improvement may be induced both in the condition of the lids and of the cornea; but there will still remain certain inveterate cases, incurable by any ordinary treatment, either local or general. They usually present a granular condition of the palpebral conjunctiva, which, however, may have been got rid of, or greatly subdued, by treatment; the characteristic sign, which makes the disease so formidable, is the haziness and vascularity of the cornea.

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* Power, in a pamphlet on the Egyptian Ophthalmia, published in 1803, describes a species of the same disease as being "frequently prevalent among the Irish peasantry, and considered by them to be infectious." See also a paper by Wilde in the *London Journal of Medical Science*, vol. iii. 1851.

We will suppose a case in which the granular condition of the lids has been partially or wholly cured, and the general health restored; but where, after exhausting every resource of his art, the Surgeon still finds the patient's corneæ permanently opaque, and traversed in all directions by vessels, vision being limited to the mere recognition of large objects. There may be every reason to believe that the tissues of the eye posterior to the cornea still remain healthy, and yet the condition of the latter destroys all hope of good vision being regained.

For such desperate cases a seemingly desperate remedy,—*inoculation*,—has been proposed, consisting in the production of a fresh attack of purulent ophthalmia, by applying to the conjunctiva some morbid secretion from the eye of a patient suffering under the acute form of that disease.

This treatment was extensively tried in Germany several years ago, but seems to have fallen into disuse, and only of late to have been revived. Its advocates asserted that purulent ophthalmia, thus produced in an eye which had previously undergone the disease, would cause a wasting of the vessels overspreading the cornea, and ultimately restore its transparency. There seemed, however, a great risk of the second attack proving as severe as the first, and ending in destructive ulceration of the cornea; and the fact of the inoculation serving to keep up and perpetuate a dangerous and contagious disease, also operated with many Surgeons as a reason for wholly discountenancing the practice. These considerations for some time induced me to abstain from the experiment. I had seen cases in which inoculation was followed by perforating ulcer of the cornea; but, at the same time, I had seen others in which considerable clearing of previously opaque corneæ took place without any ulceration whatever.

I therefore tried inoculation in a case which seemed peculiarly suitable for it. The patient, a discharged soldier, was in good general health, but quite helpless in consequence of the state of his corneæ. They were so hazy that the position of his pupils could not be traced, and were traversed in every direction by vessels. He had perception of reflected light and colours, but could not distinguish a hand from a sheet of paper, except by the difference of tint. Although the granular state of the lids had been nearly subdued, the condition of the corneæ during three years had been proof against every mode of treatment.

Some pus from the eye of a patient with purulent ophthalmia was applied to each conjunctiva. Intense inflammation set in, and on the third day there was already chemosis with thick purulent discharge. A week later, both corneæ were so covered with a yellowish flocculent layer as to appear to be in a state of complete slough. This substance, however, in the course of a few days, had disappeared, and the corneæ were found to be entire, presenting a somewhat translucent aspect, although the chemosis and discharge still continued. As no local application except cold water was permitted, and no astringent used to control the discharge, it continued in a slight degree for some months. Meantime the corneæ, as they became clearer, presented but few traces of the vessels by which they had been so plentifully traversed. Six months after inoculation, the patient could recognise features at a distance of twelve feet, and with perfect security could go about the streets of London alone. There still remained such a degree of haziness about the centre of each cornea as prevented him from reading ordinary type, No. 16 of Jäger's specimens being the smallest characters he could readily make out.

So many cases of inoculation have been reported, that I should not have quoted this single case, except on account of its illustrating a point which I think has not been sufficiently attended to, namely, the varying results of inoculation in respect of corneal ulceration.

The vitality of the cornea is put to a very severe test when the suppurative inflammation sets in with such intensity as is exemplified in the case just mentioned. If the cornea be abundantly supplied with blood by vessels traversing it in every direction, it will probably resist both ulceration and sloughing; whereas, a simply opaque and non-vascular cornea may be destroyed, or, at least, perforated, on account of mere deficiency of blood-supply. The abundant vessels which had prevented the cornea duly performing its function of transmitting light, serve to keep it alive while the inflammatory stage is going on, and so enable it eventually to recover its transparency and usefulness. The very circumstance, therefore, of the cornea being in a hyperæmic condition is favourable, as regards its ability to support the violent means employed for the restoration of its transparency.

Those who for the first time resort to inoculation in a case of corneal opacity, resulting from bygone purulent ophthalmia, will probably be dismayed when they witness the immediate result of their experiment; and will give up the cornea for lost when they see it overlapped and nearly hidden by chemosis, and catch a glimpse of its dead-yellow, slough-like surface. This, however, becomes detached, and leaves beneath it a translucent cornea, which, provided it has been well nourished with blood, may gradually advance in clearness, until it almost loses the marks of its former degeneration.

Throughout the treatment no attempt is to be made to arrest the discharge, cold water only being used as an external application in cleansing the eye. The patient should be allowed a nutritious diet, and on no account undergo depletion.

Even under the most favourable conditions, as regards the patient's general health, and the blood-supply of the cornea, inoculation must be a hazardous experiment; and it should, therefore, be reserved for those cases where the vascular opacity of the cornea has bidden defiance to all other forms of treatment, and has deprived the patient of all useful sight.

Purulent Ophthalmia of Infants.

(*Ophthalmia neonatorum.*)

This disease is closely allied in its symptoms to that just treated of, although not arising from the same specific form of infection.

Both diseases derive all their importance from the liability of the *cornea* to become ulcerated. The cause of *ophthalmia neonatorum* has given rise to much controversy; some regarding it as only an aggravated form of catarrhal ophthalmia, while others consider it as in every case due to contamination with the vaginal discharge of the mother. The latter is perhaps the more probable explanation, the difference in the intensity of the disease depending upon the more or less virulent nature of the discharge.

The ophthalmia begins a few days after birth. It may not for some time assume any intensity, and hence it is often overlooked in its early stage; and we are told that it did not begin till the child was two or three weeks old. When the child is jaundiced, the discharge assumes a deep yellow colour.

The Surgeon's first object should be to ascertain to what extent the corneæ are involved. Having secured the infant's head between his knees, he should carefully introduce between the lids a wire speculum, of a size and strength of spring proportioned to the small palpebral opening of so young a child. With a bit of moistened lint the discharge should be gently wiped away, so that the surface of the cornea may be thoroughly explored. If an ulcer exists, it will most commonly be found at the centre. It may occupy the whole area of the pupil, or involve all the cornea except its extreme edge, or the iris may be seen protruding through a complete perforation of the cornea in the form of a brownish nodule. If the whole cornea be destroyed, the iris will be seen bulging forward, covered by a thin glaze of semitransparent inflammatory deposit. Sometimes it seems as if the posterior elastic lamina had resisted the ulcerative process, and still formed a thin coating to the bulging mass of iris. These are the cases which eventually exhibit *staphyloma;* the deposit upon the iris becoming by degrees thicker and denser, and assuming very much the appearance of opaque, or partially opaque, corneal tissue, over the surface of which, at a later period, arborescent vessels ramify. When the perforating ulcer of the cornea is very large, it not uncommonly happens that the lens escapes through the aperture.

When the purulent ophthalmia is at its height, the lids are red and swollen; but when the cornea has given way, the bright rosy tint of the lids usually gives place to a dull livid colour, the swelling subsides, and the skin becomes flabby. The palpebral conjunctiva, when cleansed from the discharge, appears bright red and villous.

Treatment. The nutrition of an infant attacked with purulent ophthalmia is so important,—as the means whereby the ulcerative process may be averted; or, if that process have already commenced, reparative material may be supplied for filling up the breach,—that, before alluding to local treatment, I would insist upon the importance of the child being suckled, and not brought up by hand. A weakly infant, attacked with severe ulceration of the cornea, and fed with artificial food, has hardly a chance of recovery. Of course the condition of the bowels must be attended to; but care must be taken not to lower the child by unnecessary doses of "gray powder,"—that panacea for infantile complaints, according to popular belief. Weakly children are often benefited by a few drops—four or five—of Battley's liquor cinchonæ, given in a tea-spoonful of milk twice a day.

In the local treatment, all depressing and so-called "antiphlogistic" measures are to be carefully avoided. Blistering is perfectly ineffectual towards controlling the discharge, and only weakens and irritates the general system. Abstraction of blood by leeches is even worse, as depriving the child of that reparative material which is so urgently required for averting or healing ulceration. I know of no application better than a solution of alum, five, eight, or ten grains to the ounce of distilled water, which should be injected between the lids every half-hour. It is well to inject a little warm water before using the alum-lotion, so as to wash away the discharge, and thus allow the alum to come completely into contact with the inflamed conjunctiva.

As the discharge abates, the lotion may be injected less frequently,—every hour, or every two hours. Care must be taken not to chill the infant by wetting its clothes during the injecting.

The condition of the cornea must be carefully inspected from day to day. If there be a large ulcer, and the reparative process have set in, the Surgeon must not be uneasy on observing that the surrounding portion of the cornea looks cloudy and reddish. This pink tinge is owing to the presence of blood-vessels, advancing towards the ulcer, and conveying to it reparative material. When the ulcer has become completely filled up, these blood-vessels will gradually disappear, and the peripheral portion of the cornea, in which they ramified, will resume its transparency.

Sometimes it is useful to change the local application, and to use a solution of nitrate of silver,—two grains to the ounce,—dropping a small quantity upon the conjunctiva twice or thrice a day. This change of stimulus often acts beneficially, when the puriform discharge has almost ceased, and the ulcer still shows little disposition to heal. As soon as the ulcer begins to fill up rapidly, the alum or nitrate of silver should be used less frequently.

In severe cases of purulent ophthalmia, eversion of the swollen conjunctiva of the lids frequently occurs. This always gives rise to alarm among those who have charge of the child, and is often a cause of anxiety to the Surgeon. It is a matter of no real importance; the eversion cannot be controlled by any artificial means, and is sure to cease as soon as the puriform discharge has abated.

SCROFULOUS OR STRUMOUS OPHTHALMIA.

(*Phlyctænular Ophthalmia.*)

If by "ophthalmia" we are to understand an inflammatory affection of the *conjunctiva*, the disease I am about to speak of ought not to be termed ophthalmia at all. It is essentially a corneal disease, the conjunctiva being only secondarily affected.

It attacks children and young persons, but certainly is not always confined to those of scrofulous constitution; at least it is met with where there is no visible glandular disease. The most striking symptom is extreme intolerance of light, *photophobia*, and general irritability both of the eyes and of the whole system. The local affection of the cornea shows itself either in a small whitish elevation (the *phlyctænula* of Mackenzie), or an ulcer. In either case a long plexus of vessels runs from the corneal margin to the morbid spot. This long plexus or lash of vessels is quite diagnostic of the disease. It is sometimes seen when the rest of the cornea is almost clear, but more commonly there are several phlyctænulæ or ulcers, and the whole of the cornea is more or less hazy. The intolerance of light I have mentioned, as being characteristic of the disease, causes violent spasm of the orbicularis palpebrarum, which is increased when the Surgeon makes any attempt to examine the eyes. The intolerance is often much increased by the too common but most injudicious practice of keeping the patients in dark rooms. After many hours of darkness, the sudden admission of light is of course extremely painful. If the intolerance is very great, or the child too young to be open to persuasion, the examination must be made by means of the wire speculum.

The pain caused by exposure to light is often out of all proportion to the extent of corneal disease. In some extreme cases the Surgeon is surprised to find merely a small whitish elevation (*phlyctænula*), or an ulcer the size of a pin's head, with the characteristic streak of vessels reaching to it from the edge of an almost clear cornea.

In true cases of scrofulous ophthalmia there is hardly any increase in the mucous secretion from the conjunctiva, but the flow of tears is profuse, and they gush out each time the lids are separated. There is a more or less marked zone of vessels in the sclerotic immediately around the cornea, but no general redness of the globe, the chief increase of vascularity being due to distension of the larger veins of the conjunctiva. The lids are often raw and excoriated at the edges, and the outer commissure inclined to crack and bleed. Swollen and fissured lips and alæ nasi, excoriations and cracks behind the ears, eczema on various parts of the face, and eruptions on the scalp, are occasionally found to accompany this disease of the eyes in the more severe and long-continued cases.

Treatment. Both the skill and patience of the Surgeon are often severely tried by cases of scrofulous ophthalmia, especially if they have been neglected, or treated injudiciously, before coming into his hands. Long-continued doses of mercury, seclusion in dark rooms involving the loss of air and exercise, and too much of food and stimulants, are the common sources of unsuccess as regards general management, whilst the local application is too often just that which is most hurtful—namely, nitrate of silver.

Under the head of Catarrhal Ophthalmia I have spoken of the valuable properties of this substance in solution, in cases where the inflammation is limited to the conjunctiva; and I have also mentioned how beneficially the application of the solid nitrate acts in arresting the rapid ulceration of the cornea in purulent or gonorrhœal ophthalmia. But the too common practice of dropping-in a solution of the nitrate in cases of scrofulous ophthalmia, where the cornea is attacked either with phlyctænulæ or ulcers, is most mischievous, and often prevents the cure of a case which in other respects may have been judiciously treated.

I have said that children attacked with scrofulous ophthalmia should by no means be shut up in dark rooms. Light is as essential to the health of animals as of plants, and all inconvenience from bright light can be averted by the use of a large shade, or in elder children a pair of tinted spectacles. Out of doors a blue or green veil may be added. Moderate exercise in the open air should be taken whenever the weather is mild and dry, and sea-air is generally the most desirable, provided the place selected be not too bleak and windy. I have alluded to the ill effects of too much food and stimulants; but in doing so I would not be supposed to recommend low diet; on the contrary, there should be an abundance of nutritious, easily-digested food. My remark was directed against that pernicious practice of stuffing young children with more animal food than the stomach can properly digest, and over-exciting their irritable circulation with wine and beer, as if their disease could, as it were, be taken by storm and extinguished by mere eating and drinking. Of course there are exceptional instances of very weakly children who require a small quantity of wine; but, as a rule, beer is far preferable at an early age, and to those unaccustomed to stimulants pure milk will often be found of far more service.

With respect to drugs, I know of nothing so useful as iron in cases of scrofulous ophthalmia, whether attended with phlyctænulæ or ulcers. It may be given alone, or in combination with quinine, according to circumstances. The reason why iron is so often ineffectually prescribed in this disease and in many others, appears to me to be that it is given in too large doses and at wrong times. The form I prefer is the tinctura ferri sesquichloridi, in doses of 5, 10, or 12 drops, twice or thrice a day, to children ranging from five to fifteen years of age. It is best taken in water, and always immediately after a meal. Weakly children may at the same time take with advantage cod-liver oil. Every fortnight or so the iron may be discontinued for a couple of days, and if the bowels have become confined, or the liver appear to be deranged, a mild aperient may then be taken, with half a grain, a grain, or two grains of calomel, according to age and constitution.

Of local applications none are so generally employed as blisters; and no doubt, when used judiciously, they are very serviceable in subduing that intolerance of light which is one of the most distressing features of the disease. But here again a great mistake is frequently made in applying blisters of too large a size, and without sufficiently discriminating between those constitutions that will and those that will not bear them.

In feeble anæmic subjects a blister, even of small size, will often produce considerable depression, and in very young children with irritable skin will bring out a troublesome eczematous eruption. The best effect is produced by applying blisters the size of a shilling or a florin to the temple, allowing the part to heal quickly, and repeating the blister when the cuticle is reproduced at the end of a week or ten days. A more rapid form of counter-irritation is that produced by undiluted tincture of iodine, painted on the skin of the upper lid. This may be repeated as often as the skin recovers its natural condition.

The lids may be bathed night and morning with warm water, or the steam of hot water may be allowed to play against them, which avoids the mechanical irritation of rags or sponges.

Spermaceti-ointment, or fresh olive-oil, may be smeared along the eyelashes at bedtime. Lotions of acetate of lead, or alum, two or three grains to the ounce of water, are sometimes useful where there is on the cornea merely a small opaque patch (phlyctæna), with the characteristic lash of vessels running to it; but whenever an ulcer exists lead-lotions are improper, as the carbonate of lead, which is precipitated from them, is liable to form an insoluble white deposit in the cicatrix.

Leeches always do harm in cases of true scrofulous ophthalmia with ulceration of the cornea. The barbarous proceeding termed "scarification of the lids," is, I hope, so nearly obsolete as not to require notice.

To get rid of the plexus of vessels running from the edge of the cornea to the phlyctænula or ulcer on its surface, it has been gravely proposed that the vessels should be cut across with a lancet. This is, indeed, beginning at the wrong end! "*Ubi stimulus, ibi affluxus*;"—so long as an irritable patch of deposit, or an ulcer exists, so long will an irregular supply of blood be sent thither. Heal the ulcer, or get rid of the irritability of the cornea, by constitutional means, and the plexus of vessels will vanish.

The opacities remaining after a long-continued attack of scrofulous ophthalmia are, to a certain extent, permanent; that is to say, if they result from the healing of ulcers. But if the ulcer be superficial and the child very young, it is surprising to see how faint a trace remains in after life, to mark the site of the cicatrix.

EXANTHEMATOUS OPHTHALMIA.

(*Ophthalmia morbillosa; Ophthalmia scarlatinosa; Ophthalmia variolosa; Ophthalmia erysipelatosa.*)

The various forms of ophthalmia accompanying the exanthemata have been described by some authors with considerable minuteness; but if we restrict the term ophthalmia to signify an inflammation of the conjunctiva, it is perhaps in measles only that any very marked ophthalmia can be said to occur. Taking place, as it does, at the onset of the attack, it is one of the most marked symptoms of the disease, but demands no special treatment. The really important affection connected with measles, is the *ulceration of the cornea*, which results from the general debility produced by the disease. This ulceration is commonly attributable to a neglect of tonic treatment after the inflammatory symptoms have passed away. Iron and quinine, alone or in combination, cod-liver oil, the various influences of fresh air and nutritious diet, are all to be put in requisition to avert or to heal these ulcerations.

Scarlatina, on account of the greater exhaustion of the powers of life which it induces, is still more likely than measles to be followed by ulcers of the cornea. In some extreme cases of this frightful disease, the corneæ lose their vitality, and entirely slough away. The same system of tonics and nutritious diet which I have mentioned as useful in averting the sequelæ of measles, would be still more urgently called for after an attack of scarlatina.

During erysipelas of the head and face, in the severe form, the lids are so completely closed by the swelling of the skin, as to hide the eyes from observation. In the stage of debility succeeding the attack, ulceration of the cornea may arise, as in the two diseases above mentioned; or the cornea may even slough, as in scarlatina.

Of all the exanthemata, small-pox produces the greatest damage to the eyes; and a large proportion of those persons whom we see with shrunken globes, or with their corneæ converted into chalk-like cicatrices, have lost their sight from the ulceration induced by this disease. It was formerly supposed that these opacities were produced by pustules on the cornea itself; but it has been ascertained that pustules never form on this part, the opacities being invariably the result of ulcers, caused by the extreme prostration which succeeds the inflammatory stage.*

CHRONIC OPHTHALMIA.

The acute stage of common catarrhal ophthalmia, if neglected, is apt to subside into a chronic form, characterised by a congested state of the palpebral conjunctiva with an increase in its mucous secretion, an unnatural fulness of the caruncle and semilunar fold, and some degree of redness along the tarsal edges. The patient complains of a sensation like that produced by a small foreign body beneath the lids; luminous bodies appear surrounded by a halo of prismatic colours; the eyes water when exposed to bright light or cold winds; and the lids are gummed together in the morning.

The Surgeon, on first seeing such a case, should most carefully explore the edges of the tarsi, to see if any fine eyelashes are growing irregularly, so as to touch and irritate the globe. A single delicate hair, so fine as almost to elude observation, will sometimes suffice to keep up, or even of itself to produce, most of the symptoms I have just described.

Chronic ophthalmia, characterised by the above symptoms, is not always a sequela of acute inflammation. Indeed, it more commonly occurs as a primary disease, in persons whose occupations oblige them to sit for many hours in close and over-heated rooms, while engaged on minute objects, especially under artificial light.

Treatment. When we consider the various classes of persons liable to chronic ophthalmia, it is obviously impossible to lay down rules of treatment which shall be universally applicable. To rectify whatever may be found amiss in the general health, is the first indication. The injurious effects of artificial light chiefly depend upon the abundance of red rays inseparable from every form of it. These may be modified by adapting to the flame of the lamp, or gas-burner, a chimney or shade of transparent glass, slightly tinted with blue. The colour should be so faint as only just to whiten the flame, without imparting to it any decidedly blue tinge.

An immense variety of substances has been used in lotions and drops for the cure of this troublesome affection. Acetate of lead, alum, sulphate of zinc, nitrate of silver, sulphate of copper, tannin, &c., have all found their special admirers. Vinum opii was long a favourite form of drop; while the more homely washes of diluted brandy or vinegar have found favour as domestic remedies. Whatever form may be preferred, care should be taken not to make the solution too strong, and not to use it for too long a time without intermission. The object should be to stimulate the conjunctiva for a short period, and then to give it time to resume its natural functions. Many persons, by the habitual use of strong lotions, keep up the very condition they are seeking to cure. Acetate of lead, or alum, in the proportion of from two to four grains in the ounce of water, are perhaps as useful as any of the more common substances. Bathing the eyes in cold water, night and morning, is in many cases preferable to the use of any medicated lotions. An occasional small blister to the temple is useful when the eyes become suddenly irritable and intolerant of light.

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* For this important fact we are indebted to the extended observations of Mr. Marson, at the Small-pox Hospital. (See a paper by him in the 24th vol. of the *London Medical Gazette*, 1839.)

INJURIES OF THE CONJUNCTIVA.

The more serious of these are due to contact with escharotics, heated fluids, or melted metal. Slight lacerations or cuts of the conjunctiva, not involving the sclerotic, require only very simple treatment—water-dressing and closure of the lids. Strong mineral acids, caustic alkalies, and other chemical substances, often produce the most destructive effects upon the conjunctiva and cornea, causing bands of adhesion to form between the lids and the globe, and inflicting upon the cornea such an amount of opacity as wholly to destroy sight. The damage in these cases is so instantaneous that the Surgeon has hardly ever the opportunity of neutralising the destructive fluid. If at hand at the moment of the accident, he would of course at once inject between the lids such a fluid as would chemically decompose the acid or caustic alkali, and form a neutral salt. Afterwards a little castor-oil or olive-oil may be dropped upon the surface of the globe, and water-dressing applied over the closed lids.

Where melted metal has spurted into the eye, the Surgeon should always evert the upper lid, and explore all the folds of the conjunctiva; for large portions of metal will sometimes lodge beneath the lids in the most singular manner, and remain there quite unsuspected for a long time.

When lime, mortar, sand, or other solid matters, have been thrown against the eye, the upper lid must be everted, and every particle of grit removed in the most careful manner with a small scoop. In such cases it will not do to trust to injections of water only, although they may be useful after the scoop has done its work.

If the surface of the conjunctiva presents an opaque thickened appearance, as if it had been boiled, and the cornea is also of an opaque and pearly hue, the damage to sight is irreparable, and only slight improvement is to be hoped for. In such cases the Surgeon must take care not to weaken the patient by bleeding or low diet, for it is by keeping up the patient's reparative power that the life of the corneal fibres is to be sustained, and sloughing averted. Where a portion of the cornea is densely white and opaque, and the rest only slightly cloudy, the latter part may recover much of its natural transparency.

In those cases where the opposed surfaces of the palpebral and ocular conjunctiva have sloughed, it is impossible to prevent the formation of bands of adhesion; but these may be somewhat limited by the frequent use of a probe, to break down the newly-formed granulations.

Affections of the Subconjunctival Tissue.

ŒDEMA.

Pressure upon the trunk of the ophthalmic vein or its branches, by obstructing the return of blood from the conjunctiva and subjacent areolar tissue, is liable to produce œdema. In slight cases the œdema is confined to the lower part of the globe, where the distended conjunctiva sometimes overhangs the edge of the lower tarsus; it is only in extreme cases that the œdema extends to the upper part of the globe. In old persons, whose tissues are very lax, I have seen the margin of the cornea overlapped by the œdematous conjunctiva.

Œdema and chemosis only differ in degree; the former being a mere exudation of serum in consequence of pressure on the veins leading from the part, while the latter term is restricted to those cases where the conjunctiva and subjacent areolar tissue are actively inflamed. Abscess in the lids or in the lacrymal sac, tumours, and exostoses in the orbit, periosteal thickening in the neighbourhood of the ophthalmic vein,—in short, any direct pressure on this vessel may give rise to œdema, which cannot therefore be regarded as of itself constituting a disease, or as demanding attention, except as a symptom of something more important which has given rise to it.

PINGUECULA.

After the middle period of life, especially in persons who have been much exposed to the weather, or have lived in hot climates, it is very common to see small yellowish elevations on the sclerotic, close to the edge of the cornea, and on the equator of the eyeball. They are sometimes surrounded and traversed by a few fine vessels. When these little elevations attain their full size, they will be observed to have a somewhat triangular form, the base corresponding to the cornea. They have received the name of *pinguecula* from their being supposed to consist of fat; much of their bulk, however, is made up of fibrous tissue. Pingueculæ are growths so entirely harmless that they would not call for a remark, were it not that they very often give rise to the most serious alarm in the patient, who believes that they will gradually grow over the pupil and obstruct the sight. An explanation of their real nature comprises all that is required of the Surgeon.

PTERYGIUM.

This consists in a reddish, fleshy-looking growth extending from the semilunar fold to the cornea, the margin of which it frequently oversteps. It has a triangular shape, its base corresponding to the inner canthus. Slighter forms of this growth are met with, in which, instead of looking like a portion of muscle, the fibres are so thin and delicate as rather to resemble an aponeurosis with a few muscular fibres intermixed. No muscle, however, is found in these growths, which consist of fibrous tissue abundantly intermixed with blood-vessels.

Pterygium, like pinguecula, is found in persons past the middle period of life, and especially among those who have lived in tropical countries. The dust, which is there so abundant, may probably be an exciting cause. A very well-marked case came under my care in a mason and plasterer, who, although always residing in the neighbourhood of London, had of course been much exposed to dust of various kinds. The largest pterygium I ever saw, however, was in a countryman from Essex, in whom the apex of the growth, instead of stopping short of the area of the pupil, as is commonly the case, extended so far across the cornea as almost to hide the whole of the pupil. In this case I removed the growth; and whenever the apex extends so far as to occupy a large portion of the cornea, the deformity it produces may demand an operation. The lids being held asunder with a spring speculum, the lax portion covering the sclerotic is to be nipped up in a forceps, and cut across with a fine scalpel midway between the edge of the cornea and the semilunar fold. The portion extending towards the cornea may then be dissected off the sclerotic, great care being taken when that part is removed which adheres to the cornea. It is well not to remove the inner third of the pterygium, as otherwise the semilunar fold and caruncle are apt to retract, which afterwards gives an unpleasant prominence to the eyeball.

No other local treatment than removal with the knife or scissors is of any avail in getting rid of a pterygium. Stimulating lotions and drops only excite it to grow, and the varieties of pterygium described by authors, under the names of *sarcomatous*, *fungous*, *cancerous*, and *malignant*, were probably nothing more than common forms of the growth, irritated and teased by escharotics.

FATTY TUMOURS.

Fatty deposits to any large extent beneath the conjunctiva are uncommon. The few cases I have seen occurred in children, and the tumours all occupied the same position, namely, the line of reflection of the conjunctiva from the lower lid on to the globe. They extended from near the lower edge of the cornea to the outer canthus, were of an elongated form, almost resembling a haricot bean, and were partly concealed by the lower lid. On dividing the conjunctiva and their proper fibrous envelope, the fatty mass was easily turned out.

CYSTICERCUS TELÆ CELLULOSÆ.

This parasite is occasionally found in the subconjunctival cellular tissue, but it appears to be of very rare occurrence. I have seen but two instances, both in females, one patient being six, the other eighteen years old. The appearance was that of a rounded body, about as large as a pea, midway between the inner canthus and the cornea. There was a good deal of vascularity in the conjunctiva covering and surrounding it. In the first case a little watery bladder, rather larger than a pin's head, had been observed about eighteen months before the patient was brought to me. In the second case, no account could be given as to the first appearance of the growth. On the conjunctiva being divided, the cysticercus slipped out, and was at once recognised under the microscope. Sichel, in his *Iconographie*, gives a very good figure of a cysticercus in the position I have described (pl. lxxii. fig. 2), and also of one developed beneath the plica semilunaris (fig. 1). In other figures of the same plate, the animal is shown both in its natural size and magnified.

At the time I saw these two cases the connexion between the development of tænia in the intestines, and of cysticercus in other parts of the body, had not been pointed out; nor was it suspected that two creatures so dissimilar were really the same animal in different stages of development.*

STAINS FROM NITRATE OF SILVER.

Before quitting the subject of affections of the conjunctiva and subjacent tissue, I may say a few words respecting the serious disfigurement which results from the prolonged use of nitrate of silver in solution. No Surgeon who understands the real action of this substance,—its invaluable efficacy in catarrhal ophthalmia, and its inutility or injurious effects in affections of the cornea,—would be likely to employ it in such a manner as to produce permanent staining of the tissues of the eye; for in no case is its prolonged use of any service; the good it does, it does in a few days. Patients, however, have such unbounded faith in the efficacy of eye-drops and eye-waters, that they will frequently continue the use of them for months and even years. One of the worst cases of staining with nitrate of silver I ever saw came under my notice only a short time ago. A woman, with incurable opacity at the centre of the cornea—the cicatrix of an ulcer, in fact—had been ordered to use drops of nitrate of silver. This she did for some months, under a Surgeon's advice. She then went to another part of the country, but still continued the use of the drops, putting in, as she assured me, "two drops every day for *ten years*." The whole of her sclerotic was of a dirty sepia tint, most marked towards the lower part of the globe. The cornea itself slightly partook of the same tint, and the conjunctiva of the lower lid, thickened and vascular, looked as if a brush dipped in liquid sepia had been passed over it, the dull red colour of the conjunctiva being only seen where the membrane had formed a fold.

In another case, where this discoloration existed in a less marked degree than in the case just mentioned, I tried the effect of a solution of cyanide of potassium. The patient was an intelligent man, and could thoroughly understand the principle of the treatment, which was to keep the whole surface of stained tissue for a lengthened period in contact with the fluid. This was effected by the help of an "eye-glass," and I told the patient to draw down the lower lid, and to fix it against the cheek-bone with the rim of the glass, before throwing his head back. After several months but little benefit had resulted, and I then tried a solution of hyposulphite of soda, beginning with a strength of ten grains to the ounce of water—as the effect of the substance was unknown to me—and gradually increasing it up to a drachm to the ounce. The change effected was very slow, but when I last saw the patient the stain was barely traceable on close inspection.

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* See Küchenmeister *on Animal and Vegetable Parasites of the Human Body*; and Von Siebold *on Tape and Cystic Worms*; published by the Sydenham Society, 1857. See also the Appendix to the present work.

CHAPTER II.

DISEASES OF THE CORNEA.

Thoroughly to appreciate the slight changes in the cornea which are capable of affecting the sight, the Surgeon should clearly understand that the normal condition of the part consists in absolute transparency of its whole thickness, and perfect polish of its surface; every deviation from these conditions is an evidence of some morbid action.

When a healthy eye is examined near a window, the image of the window-frame ought to be depicted on the surface of the cornea with the most perfect sharpness and clearness of detail. A slight amount of inflammation, just enough to cause some thickening of the epithelium, destroys the brilliant polish, and causes the image of the window to appear blurred and dull, and the lines of the sash-bars crooked and wavy. This appearance is often important as giving notice that inflammation of other tissues of the eye may be going on; as in the early stage of glaucoma, where this dull condition of the epithelium is always to be seen.

Conical Cornea.

(*Hyperkeratosis*,—the tissue of the cornea being erroneously supposed to be in excess; *Staphyloma corneæ pellucidum; Keratoconus.*)

This curious and rare[*] malformation consists in a change in the form of the cornea from a segment of a sphere to a cone, the transparency of the part remaining unimpaired. There seems to be no peculiar constitution which predisposes to the affection. It is met with in both sexes; in persons apparently of good general health, as well as in the delicate and sickly; nor have I ever observed that any special employment, or mode of life, could be traced as the exciting cause.

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[*] That the disease is very rare may be seen by reference to a table which I contributed to the *London Journal of Medicine* (vol. ii. 1850), showing the

The aspect of a patient with conical cornea is so peculiar, that when once seen, the affection can never afterwards be overlooked. The eye, viewed in front, has a brilliant and sparkling appearance, as if a tear were hanging just in front of the pupil. When seen in profile, the conical shape of the cornea is at once recognised. The position of the iris is unchanged, and its movements are perfectly natural; nor is any other tissue, except the cornea, observed to be affected. In saying that a conical cornea is perfectly transparent, I should modify the remark as far as concerns the extreme apex of the cone, which sometimes, when viewed closely, presents an appearance of slight opacity. In some cases this seems due to an actual haziness in the tissue itself; but the appearance is frequently due to mere refraction of the rays of light. There seems no good reason for attributing this slight cloudiness of the apex of the cone to the friction of the lids.

The apex of the cone almost always corresponds to the centre of the cornea; but in very rare cases it has been observed to deviate from this position. The deformity usually begins when the patient is between twenty and thirty. At first he grows short-sighted, but as the change goes on, a remarkable refraction of the rays of light is produced; the flame of a candle appears surrounded with a halo, then it seems to be divided into a multitude of diverging rays, and sometimes, instead of a single flame, several flames are seen, arranged in a circle. When the last stage of conical deformity has been reached, the patient cannot read, even at the shortest focus.

In the few cases in which conical corneæ have been dissected, the apex of the cone has been found very much thinned. The mode in which the disease originates is at present quite unexplained; and in proportion to the obscurity which attends its cause have arisen the most varied suggestions for its treatment. Repeated evacuations of the aqueous humour, the same operation followed by pressure on the cornea, removal of the lens by extraction or solution, displacement of the pupil towards the lateral and flatter part of the

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number of cases of conical cornea occurring among the patients annually received at the Moorfields Hospital from 1819 to 1849.

cornea,—all these, and perhaps other forms of operation, have been tried, but hitherto without benefit.

Equally ineffectual have been the lotions, the drops, the escharotics, which have been used in every possible variety. Their employment was justified by the expectation that local astringents might induce contraction in the tissue of the cornea; and if they failed to do this, they at least, if carefully used, could do no harm to the patient's system. But a plan of treatment has been devised, which appears to be so utterly irrational, and is so fraught with mischief to the digestion and general health of the patient, that I cannot quit the present subject without a few words of warning against it. The plan consists in giving the patient a grain of tartar-emetic, or a scruple of sulphate of zinc, together with two, three, or four drachms of sulphate of magnesia, every day for a year, or even longer. How any patients could be found willing to submit to such treatment is perfectly astonishing. I have, however, seen several who had done so. One poor woman had patiently undergone this "emeto-purgative plan" for one whole year, and for nine years longer had taken the mixture at intervals. She was a martyr to dyspepsia, as might well be imagined, and utterly broken down in general health. Her corneæ remained conical.

In the present state of our knowledge of conical cornea, our means of relief seem to be limited to optical contrivances. Slight cases are sometimes benefited by deeply concave glasses; but in the complete stage of the disease, the sight is little, if at all, aided by glasses of any kind. A small aperture, like a pin-hole, in a metallic plate, held close to the eye, will, in most cases of confirmed conical deformity enable a patient to read at a focus of five or six inches, who previously had been unable to discern a letter. If, instead of a hole, a slit about three-quarters of an inch long and the thirtieth of an inch wide, be made in a metallic plate fixed into a spectacle frame, a considerable extent of lateral vision is obtained, without any necessity for moving the head in the way which is necessary when objects are viewed merely through a small circular aperture.

ARCUS SENILIS.

This term is by no means well chosen, for the change in the cornea which it implies commences long before old age can be said to have arrived, and by the time the patient has reached the age of sixty or seventy, the arc has usually been converted into a complete circle. Several years ago, Mr. Canton described the appearance as being due to a fatty degeneration of the peripheral portion of the cornea; and the term "arcus adiposus" would therefore be well applied to its early stage, and "annulus adiposus" to that condition in which the white ring completely encircles the cornea. In many persons past forty years of age, in some even at a much earlier period, an opaque whitish crescent may be observed skirting the margin of the cornea, either at its upper or lower part. This opaque crescent is the commencement of the so-called "arcus senilis;" and on close inspection it will be seen that the opacity is not an extension of the white tissue of the sclerotic into that of the cornea, but that a narrow interval of partially clear cornea always intervenes between the two opaque structures. In some old persons, the circle assumes a chalky whiteness, and presents a very striking appearance.

"Arcus senilis" is considered by some observers to indicate the coexistence of fatty degeneration of the heart. As far as the eye itself is concerned, the change can be considered as of very little importance. It certainly does not, as has been asserted, in any way contraindicate the operation of cataract by extraction; for I have many times carried my section through an "arcus senilis," and the wound has quickly and firmly united.

INFLAMMATION OF THE CORNEA.

(*Keratitis; Corneitis.* The former of these terms,—from κερατίτης, horny,—is undoubtedly preferable to *Corneitis*, which is neither Greek nor Latin.)

The healthy cornea, as I have already observed, is of the most perfect transparency, and its surface smooth and brilliant in the highest degree. These qualities are lost as soon as the part becomes inflamed; a general haziness overspreads the whole structure, and the surface looks like a steamy glass.

If the inflammation be acute, a crescentic plexus of vessels will be seen passing from the edge of the cornea for some little distance —a line or more—into its substance. These vessels are so fine, and so closely set together, that they produce the appearance of a small patch of blood smeared upon the surface of the cornea. With a lens of an inch focus the individual vessels composing the plexus may be identified. This characteristic plexus sometimes involves a third or even a half of the corneal circumference.

A zone of pink vessels is always seen in the sclerotic adjacent to the cornea, whenever any form of active keratitis is present; and this sclerotic zone also exists whenever the iris is inflamed. It is therefore always to be regarded as an important sign. As acute keratitis advances, some portion of the hazy cornea may become more decidedly opaque, and of a pale yellow tint; this shows that softening is going on, which may lead to actual giving way of the part. Intolerance of light and abundant secretion of tears accompany keratitis. The larger venous trunks of the conjunctiva become full and distended, but there is an absence of that fine vascular network in the conjunctiva which characterises ophthalmia.

One eye is usually attacked at a time, but the other may sooner or later become involved, and it very often happens that the second eye becomes inflamed just as the first is recovering.

Children and young persons are the most frequent subjects of keratitis, and the disease is rare after the age of twenty. The subjects of it are usually of a weakly, irritable constitution, often pale and anæmic; in some cases presenting the swollen cervical glands, and other marks of scrofula.

The prognosis is favourable in proportion as the patient is young, and is seen at an early stage of the disease.

The mischievous and too common practice of keeping such patients confined to darkened rooms often induces a morbid irritability of the nervous system, and an intolerance of light, which is still farther aggravated by the irritating drops so unsparingly applied to eyes affected with corneal inflammation.

Under judicious management a case of keratitis occurring in a child may sometimes pass off without leaving a trace of opacity. But when the disease occurs after puberty, and is severe and obstinate, perfect transparency is hardly ever restored, and the cornea remains ever afterwards rather more convex than natural, and very faintly mottled with opacities, and partially transparent interstices. These opacities, resulting from long-continued keratitis, without ulceration, require to be thoroughly understood; for the Surgeon who has not made himself familiar with their appearance will be sure to overrate the patient's powers of sight. It seems as if long-continued keratitis in patients who have passed childhood were attended with some peculiar change in the fibres of the cornea, whereby those portions which present only the slightest traces of opacity become, from irregular refraction of the rays of light, unable to transmit a clear and well-defined image of objects.

Treatment. I have already alluded to the constitutional peculiarities commonly met with in patients who are the subjects of keratitis. They are in every way unfitted to endure the "antiphlogistic" measures recommended in so many works on eye-diseases. The diet should be nutritious and abundant, but not given in such quantities as to oppress the stomach and impair digestion. Very young children are almost always better without beer or wine. The former should be given to older children once a-day if they have been accustomed to it; but wine can only be required by children suffering from extreme debility; in ordinary cases it hurries the circulation, and increases the general irritability of the nervous system. Of course the condition of the bowels is to be carefully attended to; and where the state of the biliary and other secretions may demand the use of mercury, an occasional dose of calomel,—one or two grains, with or without a proportionate quantity of rhubarb,—is to be given; but any thing like a mercurial course is to be avoided. Iron is, of all substances, the most beneficial in cases of genuine keratitis, but it frequently fails in consequence of being given in too large doses, and for too long a time without any pause. The tinctura ferri sesquichloridi is the form I usually prefer, giving it invariably directly after food, or even during a meal, and in doses varying, according to age, from five to twelve drops twice a day. The syrupus ferri iodidi is sometimes useful. Occasionally, when the patient is feeble, ill-nourished, or of phthisical tendency, cod-liver oil may be given as well as the iron, or even, for a time, instead of it.

Counter-irritation, by means of small blisters to the temples, is often valuable in combating the intolerance of light; and tincture of iodine, applied to the skin of the lids, also conduces to the same end, and is preferable to blisters in patients of extreme delicacy of constitution. The cautions respecting the use of blisters, mentioned under the head of Scrofulous Ophthalmia, equally apply to their use in keratitis.

Inflammation of the cornea is essentially a tedious disease, and the Surgeon must often wait patiently for weeks, and even months, before the transparency of the part is restored. Hence it will be seen how necessary it is to give the tonic medicines in small doses, such as the patient can go on with for a considerable period, instead of attempting to conquer the disease at once by giving large doses, which cannot be persevered in without derangement of the stomach and liver.

Warm fomentations, night and morning, or steaming the eyes over hot water, will usually be found to allay their irritability; but all stimulating lotions and drops do harm.

How any one who has seen much ophthalmic practice can recommend the application of solid nitrate of silver to the conjunctiva in cases of keratitis, I cannot comprehend. The same substance in solution, and the sulphates of copper and zinc, are also frequently employed, and sometimes the ointments of the nitrate and nitrico-oxide of mercury are added, as if on purpose to increase the irritability already existing.

"Chronic Interstitial Keratitis."*

Under this name Mr. Hutchinson has recently described a form of inflammation of the cornea, which has long been familiar to ophthalmic Surgeons, and has commonly been regarded as originating in a scrofulous diathesis. The careful investigations of Mr. Hutchinson, however, have been chiefly directed towards ascertaining the very important connexion which he believes uniformly to exist between this corneal disease and inherited constitutional syphilis.

The subjects of this form of keratitis are children and young persons from five to eighteen years of age. The disease begins at the centre of one cornea, in the form of a diffused haziness, like that of ground glass. Very soon whitish dots appear in the midst of the haze, not on the surface, but in the very substance of the cornea. These dots generally run together, and thus increase the amount of central opacity. At first there is but little attendant vascularity of the sclerotic and conjunctiva, but as the central opacity becomes more marked, these tissues become reddened, and a fine plexus of vessels spreads on the cornea itself, and gradually pervades the opaque portion, affecting the upper and central part of the cornea in preference to its lower half. Throughout the whole course of the disease there is no tendency to ulceration.

Usually within about two months—or it may be much earlier—the other cornea begins to be affected, the disease commencing, as in the eye first attacked, by a central haziness.

The vascularity of the cornea, when the disease is at its height, is wholly unlike that which attends granular lids, and other chronic forms of keratitis. In the latter the vessels are large and superficial, whereas in the disease now under consideration they penetrate the cornea so deeply, and are so fine and closely set together, that the effect produced is that of a tissue infiltrated with blood.

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* Mr. Hutchinson's careful observations have so clearly established the syphilitic origin of this disease, that I think we might now fairly discard the name he has hitherto applied to it, and designate it by the shorter one of *syphilitic keratitis.* No confusion could arise from the use of this term, because there is no special form of keratitis connected with *acquired* syphilis, the chronic interstitial inflammation being met with exclusively as a sequela of the *inherited* taint.

So far from this "chronic interstitial keratitis" being a scrofulous affection, in the ordinary sense of that term, Mr. Hutchinson has observed the subjects of it to be but rarely affected with enlargement of the cervical glands; while in thirty-one out of the sixty-four cases he has recorded he obtained a clear history of the occurrence of syphilitic symptoms during infancy, such as "rash," sore mouth, ulcers about the anus, prolonged "snuffles," &c.

Females appeared to be more liable to the affection than males, and most frequently it was an eldest child that came under observation.

"In almost all cases the subjects of this keratitis," says Mr. Hutchinson, "present a very peculiar physiognomy, of which the most striking signs are, a coarse flabby skin, pits and scars on the face and forehead, cicatrices of old fissures at the angles of the mouth, sunken bridge to the nose, and a set of permanent teeth peculiar for their smallness, bad colour, and vertically notched edges." He adds: "As diagnostic of hereditary syphilis, various peculiarities are often presented by the other teeth, especially the canines, but the upper central incisors are the *test-teeth*. When first cut, these teeth are usually short, and the cutting edge is narrow from side to side, and very thin. After a while a crescentic portion from their edge breaks away, leaving a broad, shallow, vertical notch, which is permanent for some years, but between twenty and thirty usually becomes obliterated by the premature wearing down of the tooth." . . . . . "I have not met with a single example of well-characterised interstitial keratitis in which the teeth were of normal size and shape."*

Treatment. Mr. Hutchinson thinks that a combined specific and tonic plan is more efficacious than one merely tonic, and advises the cautious use of mercurials and iodides, the system being at the same time supported by tonics and a liberal diet. He recommends mild mercurial ointment to be rubbed in behind the ears, in the neck, or under the axillæ, every evening, and at the same time gives iodide of potassium and iodide of iron. Ptyalism is to be carefully avoided.

I have usually employed the preparations of iron and iodine in weakly subjects, occasionally changing them for some form of bark, without the addition of mercury. The restoration of the transparency in the cornea is usually slow, and there always remains some faint trace of cloudiness in after-life.

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* For a fuller account of syphilitic teeth, see Mr. Hutchinson's papers in the *Ophthalmic Hospital Reports*, vol. i. 1858; *Transactions of the Pathological Society*, vol. ix. p. 449. See also the essay on DISEASES OF THE TEETH.

It is also not uncommon to find, when the iris again becomes clearly visible, that a slight amount of iritis has attended the inflammation of the cornea, as evidenced by a small adhesion here and there between the pupillary margin and the capsule of the lens.

Keratitis with Suppuration.

In the simple inflammation of the cornea, already described, the opacity, however dense it may be, consists of inflammatory exudation among the fibres of the part, without any destruction of the fibres themselves. Under certain conditions of the patient's system, however, the inflammation may run a very acute and rapid course, and within a few days terminate in suppuration or ulceration.

When suppuration takes place in the substance of the cornea, it is most frequently at the centre, or a little below that spot, that the pus collects. Its presence is usually manifested by a small yellowish patch in the midst of the general haziness. In very severe cases this yellow patch may rapidly spread, until the whole cornea assumes one uniform creamy tint, entirely hiding every trace of iris; the cornea then softens, and gives way at some part, the iris prolapses, and vision is eventually lost.

These are extreme cases: a more ordinary form of suppuration is that in which the pus gradually infiltrates the lower third, or even the lower half, of the cornea, and at last makes its way through the posterior elastic lamina, and then sinks down to the bottom of the anterior chamber, where it forms what is termed *hypopyon.*[*]

The giving way of the posterior elastic lamina of the cornea is sometimes speedily followed by that of the anterior lamina, and in that case a perforation is established, through which a prolapsus of the iris takes place. This perforation of the cornea is followed by immediate relief of the severe pain which had existed as long as the pus was pent up among the fibres of the cornea, or in the anterior chamber. This pain is often severe to a degree quite incredible to those who have never witnessed such cases, assuming the form of neuralgia, and wholly preventing sleep.

Treatment. In general surgery we are so accustomed, whenever an abscess forms, to regard its evacuation as the very first indication for treatment, that I may be expected to mention a puncture for giving exit to the pus, as the most important step in treating a case of suppuration in the cornea. But although it is common to speak of *abscess* in this part, the matter is not contained in a distinct cavity, but is infiltrated among the corneal fibres, so that if an incision be made, the pus does not flow out. The cornea, too, differs from every other superficial tissue of the body, in being transparent; and we should avoid inflicting any unnecessary wound, even to the smallest extent, upon a structure, the transparency of which is essential to sight.

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[*] This collection of pus at the bottom of the anterior chamber is by some authors termed *onyx;* others use the latter word,—now almost obsolete,—to signify an abscess in the substance of the cornea.

The general tonic plan of treatment I have sketched out as suitable to cases of common keratitis will be applicable, with certain modifications, to keratitis with suppuration. We must take care not to reduce the patient's vital powers; for if we do, not only will the softening of the corneal tissue be likely to spread, but if perforation of the cornea takes place, there will be a deficiency of reparative material to fill up the breach, and a large prolapsus iridis, with consequent distortion or obliteration of the pupillary opening, will be the result.

In the very early stage of suppuration, when a small yellowish patch in the midst of the hazy cornea is all that is seen to mark the beginning of suppuration, blistering to the temple sometimes aids in checking the formation of pus; but when a considerable portion of the cornea has become infiltrated, and severe neuralgia sets in, blistering only aggravates the pain. Narcotics must then be given; to children, a few drops of tincture of hyoscyamus at bedtime; to adults, a fuller dose,—ʒss. or ʒj. In very severe cases of neuralgia in the fifth nerve, hyoscyamus will be found unavailing, and morphia must be resorted to, especially if the patient be accustomed to the use of opium. Sometimes a piece of lint, steeped in chloroform liniment, and laid upon the temple and forehead, over the region of the lacrymal and supraorbital branches of the fifth nerve, is of great service in lulling the pain.

If the infiltration and softening of the cornea go on to perforation, the aqueous humour at once drains away, and then the neuralgia usually ceases, or is mitigated in a remarkable degree. If the pain ceases, so as to allow the patient to obtain sleep without the aid of narcotics, they ought, as soon as possible, to be laid aside; for they almost invariably take away appetite, and the patient is now in need of good nourishment to hasten the repair of the breach in the cornea.

Bark and ammonia, or quinine, may be required at this stage of the disease; but a carefully regulated nutritious diet, with a moderate amount of stimulants, must be the chief sources of the reparative process.

As respects local treatment, protection from light, and occasional fomentation with warm water or poppy-decoction, comprise all that is necessary during the earlier stage. When, however, the cornea has given way, the eyelids must be kept constantly closed, either by the application of a strip or two of plaster, or by means of a light pad of cotton-wool, arranged around the eyeball, and kept in its place by a bandage. The eye should only be opened occasionally by the Surgeon, to ascertain the progress of repair. In some cases it is useful to abstain from examining the eye for four-and-twenty or eight-and-forty hours.

When prolapsus iridis has occurred, this occlusion of the eye is especially useful, as, by keeping the parts at rest, an opportunity is afforded for the adhesion of the protruded iris to the edges of the aperture in the cornea. As soon as this adhesion has taken place, no more iris can escape, and the prolapsed portion gradually shrinks, and flattens down to the level of the cicatrix. When, from want of vigour in the patient, the adhesive process is sluggish, it is sometimes useful lightly to touch the prolapsus with a point of nitrate of silver.

To attempt to return a portion of iris which has prolapsed through a loss of substance in the cornea, is utterly futile; for it will escape again and again, so long as there exists an aperture for it to escape through.

Disease of the fifth nerve, caused either by pressure on its trunk, as it is emerging by the side of the pons Varolii, or by primary degeneration in the tissue of the nerve itself, will give rise to a form of keratitis with suppuration very similar to that described in the preceding pages. In the cases of disease of the fifth nerve which I have seen, this affection of the cornea has not come on during the neuralgic stage, but at a later period, when, in consequence of partial or total destruction of the trunk of the nerve, there has been anæsthesia of the parts supplied by the ophthalmic division. In three or four cases which I have watched, the whole cornea was not destroyed; but after perforation had occurred, the process of softening ceased, and reparation so far took place that eventually there remained only an opaque cicatrix in the cornea, to which a portion of the iris adhered.*

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* In a paper, published in the eighteenth vol. of the *Medico-Chirurgical Transactions*, 1845, I drew attention to the fact, that anæsthesia of the

ULCERS OF THE CORNEA.

Under the various heads of *Purulent*, *Scrofulous*, and *Exanthematous Ophthalmia*, and in the section on *Keratitis*, I have mentioned the more formidable kinds of ulceration to which the cornea is liable. The cases, however, are very numerous in which corneal ulcers are developed in a more isolated manner than in any of the above-mentioned diseases, being unattended with either purulent discharge from the conjunctiva, or general inflammation of the whole cornea.

Persons of all ages are liable to corneal ulceration. It is essentially a disease of debility, attacking those whose general power has been lowered by some exhausting illness, by bad or insufficient food, or some other depressing agency.

In persons of feeble reparative power, an ulcer, instead of healing up to the level of the healthy cornea, sometimes forms a slightly depressed cicatrix. It is of course most important not to confound the two conditions, as is often done by those unaccustomed to the observation of eye-diseases. A recent ulcer, in which the destructive process is still going on, presents a sharply-cut, well-defined edge, with little, if any, surrounding opacity, and the excavation itself, as regards transparency, offers but little contrast to the sound cornea. An ulcer which is healing is always more or less opaque throughout, and there is a cloudy halo surrounding it; and if the ulcer be large, vessels will be seen running to it from the edge of the cornea. A depressed cicatrix, on the contrary, has its edges smoothly rounded off, and its area is slightly opaque; there is little, if any, cloudy halo surrounding it, and seldom any plexus of vessels going to it from the corneal margin. In some cases, however, a depressed cicatrix is supplied by a small vessel or two, the remains of the plexus which once carried the material necessary for the healing of the ulcer which preceded it.

If the progress of an ulcer be not arrested, it may eventually perforate the whole thickness of the cornea. The aqueous humour then escapes, the iris falls against the cornea, so that the anterior

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fifth nerve was far more frequent on the *left* than on the right side. In 1857 I forwarded to the editors of the French translation of Mackenzie's *Treatise* (vol. ii. p. 763) a note containing all the literary references to cases of anæsthesia of the fifth nerve which I had collected up to that time. The result of the analysis of fifty-one cases is as follows: in five patients the fifth nerve was affected on both sides; in thirteen the right nerve only was affected; while thirty-three patients had anæsthesia of the *left* nerve.

chamber becomes altogether obliterated, a portion of iris—large or small, according to the size of the perforation—protrudes through the opening, towards which also the pupil is displaced. If the prolapsus iridis be very large, the whole area of the pupil may be annihilated.

In rare cases the ulceration stops short at the posterior elastic lamina of the cornea, which, in consequence of the pressure from behind, is thrust forwards as an almost transparent vesicle, filling up the cavity of the ulcer. The term *hernia corneæ* has been applied to this protrusion. It would at once be distinguished from a *prolapsus iridis* by the retention of the aqueous humour, and the consequent persistence of the anterior chamber.

There is one remarkable form of corneal ulceration—which I have seen only two or three times—of a singularly destructive and intractable character. In all of the cases the patients were men who appeared by no means debilitated, as far as their general health was concerned. One eye only was attacked; the ulceration commencing at the edge of the cornea, rapidly formed a deep crescentic groove, which continued to deepen and extend itself, until it had completely isolated the central portion of the cornea, which was left standing up in high relief. This central portion eventually yielded to the ulcerative process, and sight was of course entirely lost. It was remarkable that in all the cases the posterior lamina of the cornea either remained unbroken, or was perforated to only a small extent. The form of ulceration was very similar to that accompanying gonorrhœal ophthalmia; but there was no trace of purulent discharge. There was very little pain or uneasiness, and the amount of redness in the conjunctiva and sclerotic was but trifling. Probably some change in the tissue of the vessels supplying the globe was the cause of this rapid and uncontrollable ulceration.

Treatment. I have said that corneal ulcers are almost always a result of general debility, and therefore their cure is to be sought rather by improving the general power of the patient than by local application. The exception to this rule is formed by those cases in which the ulcer is very large, and exhibits a total want of action, and by those cases terminating in prolapse of the iris. In both of these instances, the local use of the solid nitrate of silver is often a very serviceable adjunct to the general treatment.

I have already (p. 697) alluded to the mischievous effects of lead lotions, when applied to ulcers of the cornea; and solutions of nitrate of silver, if used for too long a time, will also give rise to insoluble deposits, and consequent opacities.

While every thing tending to improve the general health is to be resorted to in cases of ulceration, the occasional use of warm water to the eyes is commonly the best local application. The eye should be kept lightly covered; and if there be intolerance of light, or much pain in the eye, complete closure of the lids is indicated. This closure is especially necessary when either the iris has prolapsed, or a hernia corneæ has taken place.

I have already (p. 715) said how useless must be the attempt to push back a portion of iris protruding through a corneal ulcer. If the little nodule of iris soon becomes coated with an opaque layer of adhesive deposit, simple closure of the lids, and support of the general power by suitable diet and tonics, will suffice to cause the protruded iris to become adherent to the edge of the ulcer; after which, no further prolapse will occur. But if the protruding iris, instead of becoming coated with opaque deposit, retains its natural colour and fibrous appearance, a touch with a fine point of nitrate of silver will often set up sufficient inflammation to cause adhesive deposit to take place. In like manner the deep excavated ulcer, which sometimes forms in very anæmic and weakly persons, and threatens to perforate the cornea, or to destroy it by rapidly spreading all around its margin, may be arrested, and a healing disposition given to it, by lightly passing the solid nitrate over the whole excavation and edges of the ulcer.

Opacities of the Cornea.

It is of the utmost importance as respects both prognosis and treatment, that the Surgeon should make himself perfectly familiar with the varied appearances which corneal opacities assume. Without this knowledge, he will be constantly liable to deceive both himself and his patient, in promising the removal of opacities which are in their very nature permanent; or in pronouncing incurable, hazy conditions of the cornea, which, if promptly and skilfully treated, may be perfectly removed. To the latter class belong those cloudy opacities which I have described (p. 708) as overspreading the cornea in the slighter forms of simple keratitis. The short period, a few days or weeks, during which the cloudiness had existed, the presence of a vascular zone in the sclerotic, and some degree of irritability of the eye, would all point out the cloudiness of the cornea as being due to simple inflammatory deposit within its substance, which, under suitable treatment, may be so entirely dispersed as to leave the cornea in all its original transparency. If, on the other hand, the same amount of general haziness were known to have existed for a long time, say a year or more,—if there were a total absence of sclerotic redness, and if the eye had long ceased to be irritable, the Surgeon would know that the opaque condition of the cornea was incurable, and he would no longer attempt the use of stimulating lotions and ointments, which could only arouse fresh irritation and increase the existing mischief.

The haziness which sometimes remains after a severe and obstinate attack of keratitis, presents an appearance not easy to describe, but which the experience of a few cases will readily enable the Surgeon to recognise again. There is a total absence of unnatural vascularity about the eye, but the whole cornea is slightly shaded with a faint haziness, with intervening spaces of almost transparent tissue, through which the colour and texture of the iris and the form of the pupil can be recognised, although not in their natural distinctness. The dimness of sight in these cases seems to be out of all proportion to the amount of opacity; and the patient can perhaps merely see black streaks when looking at a page of type.

The terms *nebula*, *albugo*, and *leucoma* have been applied to corneal opacities, according to their different degrees of density; the slighter forms being distinguished as *nebulæ; albugo* and *leucoma* signifying rather the white opacity of cicatrices. The edge of a *nebula* is gradually shaded off into the surrounding clear tissue; that of a cicatrix, at least one of old standing, is more or less abruptly defined. Where a prolapse of the iris has taken place through a corneal ulcer, the leucoma which results is marked in the centre by a small blackish spot.

Treatment. As regards the prognosis of nebulæ, their possible improvement mainly depends upon the age of the patient. In infancy, it is quite astonishing to see how the rapid interchange of material, which is then going on, will diminish both the extent and the density of even large cicatrices. In an infant attacked with purulent ophthalmia, a cicatrix may at first be so large as to occupy the central third of the cornea, and yet, in after-life, a mere cloudy speck may remain opposite the centre of the pupil. At a later period of life, nebulæ, which form as the cicatrices of superficial ulcers, are more permanent; but around the denser part of the speck there is always a certain amount of cloudiness, which slowly disappears. The older the nebula, the more sharply defined is its margin.

Allusion has already been made to the permanent white deposit which occurs in corneal ulcers, when lotions containing lead have been employed. The metal is deposited in the state of carbonate, and forms a chalky-white layer on the ulcerated surface. Practice alone can enable the Surgeon to recognise these old lead-deposits. They somewhat resemble a little patch of whitewash, their margin being sharply defined, and their surface often presenting minute cracks, through which the tissue of the cornea appears as dark lines. When the ulcer has been very superficial, and the metallic deposit lies just beneath the epithelium, the Surgeon may sometimes succeed in scraping away the deposit; to do this, however, requires the utmost care and lightness of hand.

A very curious form of *calcareous deposit* between the cornea and its epithelium sometimes takes place without any previous inflammation. I believe this kind of deposit to be extremely rare, for, since I first noticed it in 1848,* I have seen only two other instances. From what I have already said concerning the nature of corneal opacities, the reader will perceive that when they are of old standing and unconnected with any existing inflammation, local treatment can avail but little. Setting aside those exceptional cases I have enumerated as removable by operation, the partial disappearance of old nebulæ is due to that change of material which is constantly going on in the human body, and which is so much more active in infancy and childhood than after the period of growth has terminated. The lotions, the drops, the vapours, the ointments, which crowd the pages of the older ophthalmic works, if not actually hurtful, as being likely to set up fresh irritation, are either altogether inert or at best they serve to amuse the patient while time is slowly changing the opaque tissues.

Injuries of the Cornea.

Abrasion. The epithelium covering the anterior surface of the cornea is liable to be torn or scratched by coming in contact with any rough substance; or a little flap of the epithelium may be partially detached and doubled down. Those who have not seen these slight cases of injury to the epithelium cannot imagine how much pain they produce, especially in persons of a sensitive nervous system. A clean cut directly through the cornea often causes far less pain than an abrasion of the epithelium so minute as to be scarcely discernible.

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* This case was first published in the Appendix to Mr. Bowman's *Lectures on the Anatomy of the Eye*, 1849; and a second time in my *Guide to the Practical Study of Diseases of the Eye*, 1855 and 1859.

Within a short time after the epithelium has been injured, the sclerotic is often much injected, and a profuse flow of tears follows every attempt to separate the lids. The Surgeon will best obtain a view of the part by placing the patient in a chair and standing behind him. As soon as the lids are widely separated, the pain almost ceases, and the Surgeon must then carefully explore the whole surface of the cornea, while the patient moves the eye in various directions, so as to allow a bright light to fall on each portion in succession. A slight irregularity and roughness at one minute spot is often all that can be found to mark the position of the injury.

The *treatment* of these abrasions is very simple. A drop or two of olive-oil or castor-oil may be applied to the abraded surface, and then the lids are to be kept closed with a light pad of cotton-wool, and a bandage, for four-and-twenty hours. As soon as the epithelium is regenerated all irritation ceases, and the uniform polish of the cornea is restored.

Contusion of the cornea. Blows on the cornea which do not cut or lacerate, but merely bruise, its tissue, vary greatly in their results, according to the violence of the blow, and the age and vigour of the patient. In the severer forms of contusion, softening and suppuration among the fibres of the cornea will probably occur, and the part will afterwards exhibit more or less haziness. But in very feeble or old persons, the whole cornea may become softened and infiltrated with pus, and in such cases the pain is often very severe.

At length the cornea gives way, the aqueous humour escapes, and the pain immediately subsides; but the whole or the greater part of the cornea becomes pulpy and disintegrated, and comes away in shreds, and ultimately the globe shrinks, or else a staphyloma is formed. The worst cases of this kind occur among paupers engaged in stone-breaking. During such work, a pair of gauze-wire goggles should always be worn.

Treatment. Even a slight contusion, if it takes effect at the centre of the cornea, must be regarded as a serious accident, on account of the suppuration and consequent haziness that may possibly ensue. We must take care, therefore, not to reduce the patient by bleeding and mercury, since by so doing the vitality of the cornea is lowered, and softening and suppuration are more likely to take place. An eye which has received a blow on the cornea should be kept closed and defended from light, and poppy-fomentation may be used, if any pain comes on. If the case be seen early, a blister to the temple is sometimes useful as a counter-irritant. A narcotic may be required at bedtime; and the diet should not be reduced below that which is suited to the patient's ordinary condition.

The setting-in of suppuration, attended as it is with pain, would require an increased dose of the narcotic; and should the cornea give way, a tonic treatment, with a suitable proportion of stimulants, would become necessary, to limit the destruction of tissue, and afford material for repair.

Incised and punctured wounds. Although cuts of the cornea are usually produced by sharp-edged or pointed bodies, they also occasionally result from sudden blows inflicted with blunt ones; and a smart stroke with a stick will sometimes inflict on the cornea a cut as clean as if made with a knife. Wounds of this latter description, however, on account of the shock given to the whole eye, are usually much more serious than those made with sharp instruments. A wound involving one-half of the corneal margin, such, for instance, as is made in the operation of extraction, may become completely united within three or four days, without inflammation occurring in any other tissue of the eyeball, whilst a much smaller cut produced by a blow with a stick or stone will be followed by severe and long-continued inflammation, ending in complete disorganisation of the globe. Small sharp bodies, such as fragments of metal or glass, when driven with great force and rapidity against the cornea, frequently produce so small a wound, that a Surgeon unaccustomed to see such cases may be apt to underrate the size of the foreign body which has inflicted the injury; the elasticity of the corneal tissue causing the wound to contract as soon as the foreign body has passed through. When a case of this kind is seen immediately after the injury, the most careful scrutiny, with all the advantages of a good light, is often required to enable the Surgeon to detect the wound. The whole surface of the iris, and especially the bottom of the anterior chamber, should be most carefully examined, in order to detect the lodgment of the penetrating body; and if the cornea be still transparent, and the aqueous humour retained, the pupil may be dilated with atropine, and the lens and deeper tissues explored with the ophthalmoscope. If any portion of the penetrating body protrude from the wound, it should be at once extracted with a fine well-closing forceps, the lids being held apart with a spring speculum, and the globe steadied by nipping up a fold of the conjunctiva covering the sclerotic.

When the wound of the cornea is large, a portion of the iris is frequently forced through the wound. If such a case is seen within a few hours of the accident, and before there has been time enough for the protruded iris to become united to the margins of the corneal wound by adhesive deposit, the portion of iris may sometimes be returned by careful pressure with a probe or small spatula. If, however, adhesion between the cornea and iris has already taken place, this reduction is impossible; and the Surgeon must then content himself with maintaining the parts in perfect rest by keeping the lids closed; or if the protruding and strangulated iris be indisposed to shrink, it may be lightly touched with nitrate of silver, and the lids again kept closed for some hours.

Sometimes the protruded portion of iris gradually becomes distended with aqueous humour, and assumes a rounded pouch-like form. This little pouch should be freely punctured, or a portion of it cut off with curved scissors, and then the nitrate of silver and the bandage applied as before.

The advice I have here given, as to returning the iris protruding through an incised wound of the cornea, may at first appear to be inconsistent with what I have before said, at page 715; but the difference between the two cases consists in this,—that when an ulcer has perforated the cornea, there is an actual loss of its substance, and if the iris protruding through such an aperture be pushed back, it will escape again and again. But in the case of an incised wound there is no loss of corneal tissue, merely a separation of its fibres; and if the protruding iris be returned into the anterior chamber, the elasticity of the corneal tissue will bring the edges of the wound into apposition, and keep them so until they have become united.

Punctured wounds of the cornea vary much in their character, accordingly as they are inflicted by means of pointed bodies of a large size, or by such small fragments as remain embedded among the fibres of the part. Wounds of the former class frequently involve other parts of the eye, and penetrate through the cornea into the iris or the lens. These complicated injuries cause either iritis or cataract, and will be spoken of in future chapters.

The simplest and by far the most common form of puncture of the cornea is that which happens when little fragments of metal or grit are forcibly projected against the eye, and remain sticking either in the epithelium or in the superficial layer of the cornea itself. Engineers, metal-turners, mill-stone dressers, stokers, are constantly liable to these injuries; and the Surgeon should be able at once to remove the foreign body without inflicting in the attempt any farther injury on the cornea. Standing behind the patient, who should be seated opposite a window, the Surgeon raises the upper lid by placing the tips of his first and second fingers against the edge of the tarsus, beneath the cilia, and then pressing the lid upwards and backwards without everting it; he then with these two fingers steadies the globe by gentle pressure just above the cornea, while the point of the ring-finger gently presses the globe at its inner side. In the other hand he holds a little spatula-shaped instrument (which for want of a better name I have called a "spud"), the flat end of which he passes under the foreign body, and so tilts it out. The point of a cataract-needle or a lancet, on account of its fineness and delicacy, is very unsuitable for extracting these little bodies. All the treatment necessary after their removal consists in keeping the eye closed for a day or so, with perhaps occasional fomentation.

If an elongated chip of metal strikes the eye obliquely, it sometimes wedges itself into the cornea at about the middle of its thickness, lying exposed to view, but so completely buried as to afford no hold to a forceps. The Surgeon must then with a cataract-knife or cutting-needle slit up the layer of corneal substance along the whole length of the foreign body, which can then be turned out without difficulty.

One of the injuries most difficult to treat is that inflicted by a sharp-pointed chip of metal just long enough to transfix the cornea, and to thrust its point into the anterior chamber, while the other extremity is so much embedded as to offer no hold for a forceps. If the Surgeon attempts to dig out such a chip, he will almost certainly drive it farther in, until at last it slips wholly into the anterior chamber, and entangles itself among the fibres of the iris.

The removal of the foreign body will call for all the operator's skill and patience, and chloroform must be used if the patient be timid and unsteady. The lids being separated with the spring speculum, an assistant fixes the globe by nipping up with a forceps a fold of the conjunctiva at its lower part. The Surgeon then, with a broad cutting-needle, makes an opening in the cornea close to its outer margin. The needle should be slowly withdrawn, without rotating it in the slightest degree, so that the aqueous humour may, as far as possible, be retained. Then a small spatula is to be passed in at the opening, and carried quickly and steadily across the anterior chamber, so as to interpose between the lens and the intruding point of the foreign body. The spatula is then to be pressed forward against the foreign body to keep it fixed, while, with a cataract-knife or cutting-needle held in the other hand, the Surgeon slightly enlarges the wound on the anterior face of the cornea. Still steadying the point of the foreign body with the spatula in the anterior chamber, he endeavours, with a very fine and well-closing forceps, to grasp the extremity of the foreign body and draw it out of the wound.

I have had occasion several times to perform this operation, which the minuteness of the foreign body, its close proximity to the transparent lens, and the necessity for limiting the extension of the external wound, combine to render one of the most difficult in ophthalmic surgery.

A foreign body, which passes quite through the cornea, may wound the lens and remain embedded in its substance, producing a traumatic cataract; or it may become fixed in the iris; or, having lost its momentum in traversing the cornea, it may fall down to the bottom of the anterior chamber. Under any of these conditions, if the Surgeon sees the case immediately after the accident, while the cornea is still clear, and the iris and anterior chamber are not yet obscured by inflammatory effusions, he should endeavour at once to extract the foreign body. If it can be distinctly seen sticking in the lens, it will be right to make a section of the upper half of the cornea, and remove the lens, as in the ordinary operation for cataract. A chip of metal, fixed in the iris, may be removed with Assalini's spring forceps,* or the cannula forceps, introduced through a small corneal wound; and in the same manner foreign bodies of any kind, which are lying loose in the anterior chamber, may be seized and extracted.

The Surgeon must not be deterred from attempting to remove these foreign bodies by the stories he will find in many of the older ophthalmic works, about the oxydation, and solution, or encysting of metallic fragments. The lymph which is thrown out around a metallic chip in the iris does indeed, for a time, encase it and hide it from view; but this is only the beginning of a tedious iritis, which will probably end in disorganisation of the eye, or, at least, produce obstruction of the pupil and loss of sight.†

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* This instrument was invented by Assalini for seizing the iris in the operation for artificial pupil; *Ricerche sulle pupille artificiali*, &c. Milano, 1811. For this purpose it has been superseded by the more delicate *cannula forceps.*

† In a case I communicated to the *Dublin Journal of Medical Science* (n. s., vol. vi, p. 210, 1848), a very minute scale of copper remained fixed in the iris for *eight years*, and, after causing repeated attacks of iritis, was at last

Foreign bodies lying loose in the anterior chamber are to be removed in a similar way to that I have just recommended in the case of bodies fixed in the iris; the extent of the corneal incision being of course proportioned to the bulk of the body to be extracted.

This may perhaps be the most convenient place to notice those rare cases in which a living entozoon constitutes the foreign body in the anterior chamber.

The *Cysticercus telæ cellulosæ* has been repeatedly met with in this situation, as a rounded, semi-transparent, vesicular body, furnished with a long retractile neck, terminating in a head furnished with suckers and a circlet of hooks. If not removed, the animal eventually sets up inflammation of the iris and cornea, which ends in total loss of vision. A crescentic incision along the edge of the cornea allows of the escape of the animal along with the aqueous humour. Cases have been reported by many ophthalmic writers, among whom Mackenzie has given the fullest details, and has figured the animal both in its natural condition and magnified.*

All the operations on the cornea just described will be greatly facilitated by the use of the spring speculum, a forceps to fix the globe, and, in irritable and timid patients, by the administration of chloroform.

The *after-treatment* of all the foregoing cases, in which an incision of the cornea may have been necessary for the removal of a

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thrust forwards against the cornea by the effused lymph; ulceration was set up, and the little fragment, projecting through the cornea, was seized and extracted.

* Mackenzie (*Practical Treatise*, &c. 4th edit. 1854) quotes a case of *cysticercus* in the anterior chamber, observed by Schott in 1830; another by Logan in 1833; and relates two cases of his own in 1848 and 1850. He also mentions a case reported by Appia, in which the *cysticercus* is said to have been seen within the substance of the cornea. In all these instances the *left* eye was affected, and Mackenzie remarks that "the left has suffered much oftener than the right eye from the intrusion of *cysticerci*, either under the conjunctiva or into the interior of the organ." Cases which have been reported subsequently to the publication of Mackenzie's work do not, however, bear out this statement. In the *Archiv für Ophthalmologie*, vol. i. p. 453, is a case of *cysticercus* in the *right* anterior chamber; and in the same journal, vol. iv. p. 113, is another, also in the right eye. When Mackenzie wrote, *cysticerci* had never been discovered in the *vitreous* chamber; but in the *Archiv* eighteen cases have already been reported, nearly equally divided between the right and left eyes. (See a subsequent note on *cysticerci* on the retina and in the vitreous humour.)

penetrating body, mainly consists in keeping the eye perfectly at rest and protected from light, while the healing process is going on. For the first twenty-four hours at least *both* eyes should be covered with a light bandage. After that period it may be sufficient to keep the wounded eye closed, and the length of time during which this closure should be maintained must depend upon the rapidity with which the wound heals, and the aqueous humour is resecreted,—circumstances varying according to the constitution of the patient, and the amount of violence inflicted on the eye by the accident and the subsequent manipulations of the Surgeon. Patients should neither be kept low nor over-stimulated, but maintained as near as possible at their natural standard of vigour. Those of an irritable temperament will often require a narcotic for several nights after these operations; but if chloroform has been used, a narcotic should not be given while the system is still under the effects of the inhaled vapour.

CHAPTER III.

DISEASES OF THE SCLEROTIC.

Inflammation.

(*Rheumatic Ophthalmia* of Mackenzie; *Scleritis*; *Sclerotitis.*)

The sclerotic is inflamed to a certain extent in all cases of keratitis and iritis, and exhibits that zone of red vessels close around the margin of the cornea which is so marked a symptom of both these diseases. A more extended inflammation of the sclerotic not uncommonly forms one of the complications of catarrhal ophthalmia.

But there is also a form of inflammation which is almost limited to the sclerotic, the conjunctiva being implicated only in a secondary degree, and this sclerotic inflammation may assume either the acute or the chronic form.

In the acute inflammation the whole of the sclerotic is intensely injected, the part assuming a peculiar pink tint, quite different from the more vermilion colour of conjunctival inflammation. In very severe cases the pink tint has a shade of violet, in consequence of the depth at which the vessels lie in the fibrous tissue. Intolerance of light and lacrymation are marked symptoms, and in and around the eyeball there is always considerable pain, which sometimes assumes the form of intense neuralgia throughout the ophthalmic division of the fifth nerve, extending even into the second and third divisions.

The attack is attended with general constitutional derangement; the tongue is coated, the appetite bad, and the urine often deposits large quantities of lithates.

Treatment. The bowels must be first thoroughly cleared, and then narcotics given, in doses proportioned to the severity of the neuralgia, and the former habits of the patient. Half a drachm, or a drachm, of tincture of hyoscyamus may be sufficient in some cases, while in others full doses of morphia will be requisite to insure sleep. In some patients quinine, in others iodide of potassium, is of great service; to those in whom the rheumatic diathesis is more marked, colchicum given in combination with an alkali will be far more beneficial. The patient's appetite is usually so bad that it requires management to induce him to take sufficient nourishment. Beef-tea, bread-and-milk, and various modifications of farinaceous food, are often more readily taken than solid meat. Sugar should be avoided, and beer, as containing sugar; dry wine or diluted spirit being substituted, and of course only given in quantities demanded by the condition and previous habits of the patient. Local depletion by means of leeches seldom produces more than temporary benefit, and blisters only aggravate the neuralgia. Steaming the eyes over hot water is usually soothing, and preferable to fomentation, in consequence of the extreme irritability of the surface of the eye. The most effectual local application is chloroform, diluted with olive-oil according to the susceptibility of the skin, and applied on lint to the temple and forehead. The patient's room should be moderately shaded from light, and the eyes still farther protected, if necessary, by a suitable eye-shade, or tinted spectacles; but complete darkening of the room is unnecessary, and it has the great disadvantage of rendering the examination of the eyes by the Surgeon intensely painful during the abrupt transition from darkness to light.

Chronic inflammation of the sclerotic occurs frequently, but by no means exclusively, in rheumatic subjects. Instead of involving the whole extent of the sclerotic at once, it commonly appears as a limited patch of redness, close to the cornea, after a time fading away, and then reappearing on some other portion of the white of the eye, but always keeping close to the corneal margin.

When this chronic inflammation of the sclerotic has gone on for a long time, it has a tendency to involve either the cornea or the iris. In the latter case the iritis is so insidious, and so slightly marked, as frequently to be overlooked; and it is not until after the sclerotic redness has wholly disappeared that some dimness of vision induces the Surgeon to make a careful examination of the pupil; when he will probably detect some small adhesions between the iris and the capsule of the lens, or a filmy opacity of the latter, dotted with minute patches of pigment.

It appears to be this form of obstinate sclerotic inflammation which Wilde* has described as "inflammation of the ciliary body." No evidence, however, exists that this structure is specially the seat of inflammation.

Treatment. Chronic inflammation of the sclerotic is a very tedious affection, and one that is extremely liable to recur, if the patients are exposed to cold and damp, or fall into that dyspeptic condition which induces chronic rheumatism. Strict attention to diet, avoidance of sugar, and substances which form sugar in the system, a dry and temperate climate, will be the best means to prevent the sclerotic inflammation from becoming periodical in its return. Quinine is commonly the most effectual remedy, and blisters to the temples are often valuable adjuncts. But if the patches of redness shift about from one side to the other, fading away at one part, only to reappear at an opposite point of the globe, a vigilant watch should be kept upon the iris, lest it should be attacked with inflammation. If the pupil becomes sluggish and slightly irregular, a careful examination with concentrated light will probably reveal a very slight, barely perceptible, deposit of lymph fringing the pupillary margin. The sight will at the same time be more or less cloudy. In such a case mercury must be carefully given to check the iritis. Two grains of calomel with half a grain of opium may be given at bedtime; or, if the iritis be more acute, and the deposit of fibrin more considerable, the calomel and opium may be given for a few days, night and morning; and as soon as the deposit begins to be absorbed, the dose may be restricted to two grains a day, or even that quantity may be given on alternate days. In delicate subjects a single grain taken every night may be sufficient from the first. The mouth must never be made at all tender, and the depressing influence of the mercury may be counteracted by a daily dose of bark, and a moderately nutritious diet. The bark should be continued in small doses for some weeks after the mercury has been left off.

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* *Medical Times and Gazette*, n.s. vol. ix. p. 515, 1854.

INJURIES OF THE SCLEROTIC.

Clean cuts of the sclerotic, inflicted with sharp bodies of various kinds, frequently involve the subjacent structures, the choroid and retina. If the latter be extensively divided, a greater or less quantity of the vitreous humour is almost sure to be lost. The laxity of the conjunctiva, however, often serves to limit the escape, as the tenacious fluid becomes entangled among the meshes of the subconjunctival areolar tissue.

The prognosis of wounds of the sclerotic depends upon their extent, the amount of vitreous humour which has been lost, and, above all, upon the fact whether or not the foreign body inflicting the wound has penetrated into the interior of the globe. The wound made by the entrance of a grain of shot is usually very small, as the elasticity of the sclerotic causes its fibres, after being separated by the shot, instantly to close up again, as soon as it has passed through them. When quite recent, a shot-wound in the sclerotic is hidden by a little patch of blood extravasated beneath the conjunctiva. The entrance of a grain of shot, or a fragment of metal, through the sclerotic into the vitreous chamber is almost certain to set up a slow inflammation of the whole globe, ending in loss of sight and atrophy of the organ.

Simple punctures and small cuts through the sclerotic, unattended with the retention of any foreign body, commonly unite very well, provided the eye be kept in perfect rest, and the reparative process be not interfered with, and checked by injudicious applications, or by general depletion and weakening of the patient's system. It seems almost superfluous to insist upon the necessity for absolute repose for the wounded organ; and yet it is wonderful to see how the good sense of the Surgeon, who would treat a fractured limb on the principle I have just mentioned, seems to desert him as soon as a wounded eye comes under his care.

Rupture of the sclerotic with displacement of the lens. A very remarkable injury sometimes happens to the sclerotic, consisting in a laceration extending completely through its substance, within a line or two of the corneal margin, while the conjunctiva remains unbroken, and the dislocated lens, slipping out through the rent in the sclerotic, becomes firmly wedged beneath the conjunctiva.

This rupture of the sclerotic always takes place on the side of the eye opposite to that which has received a severe blow with some blunt body; the fibres, being suddenly put on the stretch, give way at the point where they are the most bent. Hence it is that the seat of rupture is almost always either the upper or the inner part of the globe, the lower and the outer portions being comparatively exposed to violence, while the prominence of the eyebrow above, and of the nose internally, defends the upper and the inner portions.

Rupture of the sclerotic, with sub-conjunctival dislocation of the lens, is always attended with some injury to the iris. Either that portion adjacent to the sclerotic wound is drawn into it, the pupil remaining large, and displaced towards the margin of the cornea, or else the shock causes the ciliary attachment of the iris to give way to a greater or less extent.

It sometimes even happens that the whole ciliary attachment gives way, and the entire iris is driven completely out of the globe, through the rent in the sclerotic, along with the aqueous humour, lens, and a portion of the vitreous body. This large escape of the contents of the globe only takes place, I believe, when the conjunctiva is also ruptured.*

When a recent case of ruptured globe is seen soon after the infliction of the injury, the parts are so obscured by blood that it is often impossible to form a correct estimate of the damage the globe has sustained. Detachment of the iris from its ciliary connexion is always attended with bleeding, which may completely hide every thing behind the cornea. The lens, too, if dislocated beneath the conjunctiva, is often enveloped in blood, so that its form cannot be precisely defined. Until the blood behind the cornea has been absorbed, it is impossible to ascertain whether the retina has retained its function; so that in every case the prognosis will be extremely doubtful.

Treatment. If the detached iris is hanging out of the wound, through a rent in the conjunctiva, it should be snipped off with scissors; but inasmuch as the lens, if lying between the unbroken conjunctiva and the sclerotic, may be so obscured by effused blood as to be with difficulty recognised, it will be well to wait a few days until the blood has become absorbed, and then the division of the conjunctiva covering the displaced lens will allow of its easy removal.

Absolute rest of the eye is the one important point in the treatment of all cases of ruptured globe. For the first few days, both eyes should be kept closed, by means of strips of plaster or a light bandage. Afterwards, it will suffice to close the injured eye only; but this closure should be uninterruptedly maintained for a week or ten days.

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* See two cases in which the lens and iris were driven out of the eye through the ruptured sclerotic, published in my *Practical Guide*, &c., 2d edition, pp. 398-9. Also a case of sub-conjunctival dislocation of both lenses in the same person, p. 113, *note*.

The patient should not be kept on low diet, nor depleted in any way; least of all should he be brought under the action of mercury, as is too often done. Such treatment can only have the effect of lowering his reparative power, and so retarding the process of cure.

CHAPTER IV.

DISEASES OF THE IRIS.

Congenital Defects.

(*Irideremia; Coloboma; Misplaced pupil; Persistence of membrana pupillaris.*)

Congenital absence of iris (*irideremia*) always attracts the notice of those about the infant by the peculiar reddish glow which is reflected from the retina. The child seems to shrink from strong light, and there is a good deal of unsteadiness of the globes. When carefully examined in a favourable light, the whole space behind the cornea presents one uniform red or orange tint, while the edge of the lens is marked out by a ring of golden light.

Although the term *irideremia* would imply a total absence of iris, a slight rudiment of it is often found, forming a very narrow segment of a circle skirting some portion of the edge of the cornea.

Considering the number of infants affected with *irideremia* brought for an opinion to our public eye-hospitals, it is singular that an adult with this defect is hardly ever met with. I can only remember to have seen one such case, a report of which will be found at p. 400 of my *Guide to the Study of Diseases of the Eye*, 2d edition.

Coloboma. This congenital malformation is the result of an arrest of development, whereby the coalescence of the two halves of the iris is prevented; the pupil, therefore, presents an elongated form, extending down to the lower edge of the cornea.

Hannover describes a median fissure of the lower portion of the choroid as accompanying *Coloboma iridis.* The iris and choroid being formed in the embryo from one vascular membrane curved upon itself, an arrest of development would cause in both structures the same kind of defect along the median plane of the eyeball.

Coloboma iridis, however, is not always placed exactly on the median plane of the eye, but sometimes a little to the inner or outer side of it. It usually coexists in both eyes, although not always in the same degree. Sometimes, instead of the pupil being prolonged down to the bottom of the cornea, an abortive attempt, as it were, to form a coloboma is evidenced by a puckered groove in the iris, extending downwards from the lower edge of the pupil. The actual size of the pupillary aperture in coloboma is not always quite so great as, on a superficial inspection, it appears to be; for the extreme edge of the aperture, when minutely examined, will sometimes be found to be fringed with blackish-brown pigment; and this produces the effect of a larger area than really exists.

An old prolapse of the iris through an ulcer, situated at the lower edge of the cornea, by drawing the pupil directly downwards, may produce an appearance a good deal like a *coloboma iridis.* The white cicatrix, however, in the former case, would always enable the careful Surgeon to recognise the true character of the deformity.

Another abnormal condition of the pupils consists in their being placed near the margin of the cornea, instead of opposite to its centre. Mal-position of the lens appears frequently to accompany this eccentric position of the pupils.*

Persistence of the fœtal *membrana pupillaris* has been described as sometimes occurring, and causing an obstruction in the pupil which might be mistaken for congenital cataract. I have never met with a case of this kind; but I cannot believe that any practised observer could mistake such a membrane for an opacity of the lens; for the *membrana pupillaris* is attached, not to the very margin of the pupil, but to the anterior face of the iris at a little distance beyond the margin. I have occasionally seen what I have supposed to be slight vestiges of the pupillary membrane, in the form of one or two little spurs or tags, projecting from that part of the anterior surface of the iris where the membrane was originally attached.

In the *Albino* the iris partakes of the general want of coloured pigment which characterises the hair and skin. The layer of opaque pigment, termed *uvea*, is altogether wanting, and the structure of the iris presents a singular appearance, as if loosened by maceration. Whitish fibres are intermixed with others of a lilac colour, and through the whole attenuated iris the light reflected from the fundus of the eye transmits a reddish glow.

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* Figures of unusually extensive coloboma iridis, and of congenital malposition of the pupils, will be found in the *Ophthalmic Hospital Reports* for 1858 (plate iv. figs. 2 and 3).

Albinism is frequently attended with defective vision, and always with great intolerance of light. In some cases, however, sight is very good, and extreme sensibility to light is the only thing complained of.

INFLAMMATION OF THE IRIS; IRITIS.

Before entering upon this very important subject, it will be desirable to say a few words about the appearances which the iris presents in a healthy state; for it is subject to many variations as to colour and mobility, which, if not rightly understood, may lead to serious errors of diagnosis; mere congenital peculiarities, or changes incident to age, being mistaken for signs of disease.

The iris presents every shade of bluish-gray and brown among the fair and the light-brown races of mankind; whilst among the negro races it is uniformly found of a dark brown, approaching to black. A particoloured iris is not very rare; a fourth, a third, or even half of its surface being brown, and the rest bluish-gray; or one iris may be wholly brown, and the other as entirely gray, each eye being perfectly normal in respect of sight. Light-brown irides are often marked with two or three isolated tufts of dark pigment, and these spots are frequently causes of alarm to those who are the subjects of them.

A very slight tremulous vibration of the whole iris attends every movement of the eyeball in some persons, who nevertheless enjoy good sight; but this tremulousness must be regarded as morbid, whenever it exists to any great extent. It is quite independent of the movements of the pupil, and is best seen when that aperture is contracted, as a larger extent of iris is then open to observation. As a decidedly morbid appearance, tremulousness of the iris is familiar to us after those cases of extraction of cataract, where much vitreous humour has been lost, or after needle-operations, where that humour has been rudely stirred up and disintegrated.

The pupil is not placed precisely in the centre of the iris, but a little nearer to the median plane of the body; so that the iris is rather narrower between the inner edge of the pupil and inner margin of the cornea than on the outer side of the pupil.

Any considerable deviation of the pupil from a circular form may be regarded as the result of disease; but the pupil may exhibit, especially in elderly persons, a slight irregularity of outline, without any disease having existed in the iris.

The mobility of the iris becomes less as age advances; and, in old people, we often find a small and almost fixed pupil, the sight remaining excellent. In examining the mobility of the pupils, each one should be tested separately, the other eye being closed; for such is the sympathy between the two organs, that when, in consequence of disease in the nervous apparatus, an eye has become quite insensible to light, its pupil, otherwise motionless, will contract whenever light is admitted to the sound eye.

The earliest mention of *iritis* occurs in a treatise by Schmidt, describing the inflammatory changes consequent upon cataract-operations as performed in his day.*

It is impossible to overrate the importance of inflammation of the iris; for when we consider that the visual function of the eye ceases, if the small aperture of the pupil becomes closed, we at once appreciate the consequences of inflammatory effusion into its area.

The attention which has been bestowed upon iritis by ophthalmic writers has led many of them to indulge in minute and tedious subdivisions of the disease, and to distinguish them by complicated terms, which only serve to embarrass and confuse the practitioner. The extent to which this evil has spread can be fully appreciated by those only who are familiar with German medical literature.†

This passion for subtle refinements and nomenclature has been comparatively rare with English writers; and those whose practical experience has been the most extensive have made use of the simplest classification.

Lawrence divides iritis into *acute* and *chronic*, and limits its constitutional modifications to four: the *syphilitic*, the *gouty*, the *rheumatic*, and the *scrofulous*. Tyrrell adopts this arrangement in his *practical* work.

There are certain signs common to all cases of iritis, under whatever constitutional modifications it may be developed; such are, a well-marked sclerotic zone; diminished mobility of the pupil, with more or less change in its form; a loss of the peculiar fibrous appearance of the iris; and a change in its colour.

Other signs mark the peculiar constitutional influence which has given rise to inflammatory action in the part. These will be noticed under the proper heads.

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* *Ueber Nachstaar und Iritis nach Staaroperationen*, 1801.

† For remarkable instances of this mania for subdivisions and uncouth names, see the work of Von Ammon, *De Iritide*, 1836; and that of Rau, *Die Krankheiten und Bildungsfehler der Regenbogenhaut*, 1844.

Traumatic Iritis.

Incised wounds of the iris are not the injuries which cause the greatest amount of inflammation in its tissue. On the contrary, clean cuts, even if very extensive, produce but little inflammatory reaction; while bruising, or continued pressure of the part, such as occurs in certain displacements of the lens, invariably gives rise to inflammation and adhesive deposits.

The wounds which are sometimes accidentally inflicted on the iris during the operation for extracting a cataract, or those which are intentionally made, to form an artificial pupil, are rarely followed by iritis; and when, after a few days, the eye is examined, more or less blood may be found at the bottom of the anterior chamber, but the fibrous tissue of the iris will present almost its ordinary aspect.

The lodgment of a foreign body, however, even of the smallest size, always sets up iritis, which does not permanently cease until the foreign body has been removed. As foreign bodies, before reaching the iris, must have passed through the cornea, I have thought it best to treat of them in Chapter II., under the section, "Injuries of the Cornea."

A singular accident which sometimes befals the iris may be mentioned in this place, although it is really attended with very little iritis, namely, detachment of the iris from the ciliary ligament. The organic connexion between these two structures is so slight that a smart blow with a stick or a whip, the rebound of a twig, or the shock of a spent shot, is sufficient to sever them from each other; the extent of the separation varying in every possible degree, from a line, or less, to the complete detachment of the whole iris from its ciliary connexion.

A very slight separation may almost escape notice. It appears as a small, black, elongated spot, close to the extreme edge of the cornea. In proportion to the extent of the separation will be the amount of deformity of the pupil; and when half of the circumference of the iris has been detached, the pupil will probably fall together and be wholly effaced.*

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* The appearances presented by separation of the iris from its ciliary attachment may be seen in most of the illustrated ophthalmic works. I may instance Mackenzie's *Treatise*, 4th edition, p. 396; Cooper *on Wounds and Injuries of the Eye*, 1859, pp. 170, 173, 175.

In all extensive cases of detachment, there is bleeding into the anterior chamber; sometimes to such an amount as at first to conceal the injury from view.

Unfortunately the Surgeon can do very little in these cases. To replace the detached iris is utterly impossible, and vision must inevitably remain greatly impaired; but at least he can abstain from attempting to hasten the absorption of the effused blood by administering mercury. It may seem unnecessary to caution any one against such practice, but, in fact, the dogma that "mercury induces absorption," is so firmly fixed in some minds, that instances are constantly occurring of patients being actually salivated as a means of promoting the absorption of blood which is filling the anterior chamber after rupture of the iris. The rational mode of treatment is to defend the eye from strong light, and to keep the general vigour of the patient up to a healthy point, and then nature will in due time completely absorb the blood, without any aid from drugs.

I have observed how readily the iris inflames when subjected to long-continued pressure. The most striking examples of this are seen, when, in consequence of a blow upon the eye, the lens has been loosened from its connexions, and partially dislocated into the pupil. The traumatic iritis is still more severe, if there be, at the same time, an incised wound of the cornea. In that case, the aqueous humour drains away, and, in consequence, the iris becomes compressed between the cornea and the displaced lens.

Inflammation of the iris soon sets in; vessels become visible in its tissue, and lymph is effused into the pupil, into which the lens is bulging. The cornea becomes hazy, and is traversed by vessels. The sclerotic and conjunctiva are deeply injected, and there is abundant secretion of tears. If the case be left to itself, or injudiciously treated, the pupil becomes eventually closed with effused lymph; or else the cornea softens and gives way. Meantime the deep tissues become disorganised, and, after protracted suffering, the patient finds the eye utterly useless.

The only way to anticipate all this mischief is to remove the displaced lens, which is acting like a foreign body. To do this requires much tact and care, and, in making the requisite opening in the cornea, the Surgeon must endeavour to avoid isolating any considerable portion of corneal substance between his incision and the wound already existing in the cornea, lest the isolated portion should slough from interrupted nutritive supply. Sometimes the wound in the cornea is so placed that the Surgeon, by enlarging it, can make an opening sufficient for his purpose. But if the wound be in the centre of the cornea, it is usually desirable to make the incision in a new portion, and as near the margin as possible. If the substance of the lens has been much broken by the original injury, the greater part of it will probably escape when pressure is applied; but if the lens be almost entire, it must be broken up as much as possible before any attempt at pressure is made. The use of the scoop will greatly facilitate the removal of the disintegrated lens, the pulpy substance escaping along the groove.

The success of such an operation will depend upon its being performed soon after the accident, while the cornea is still clear, and before iritis and effusion of lymph have set in. If performed at a later period, there will be greater risk of vitreous humour being lost. In all cases the success of the operation, as regards restoration of sight, must be very doubtful; and if performed at a late period, relief of pain, and prevention of complete disorganisation of the globe, will probably be the best result that can be hoped for.

The treatment, after such an operation as I have just noticed, will be similar to that after an ordinary case of extraction of a cataract. Closure of both eyes for four or five days will be necessary, and the reparative powers of the patient must not be depressed by privation of due nourishment.

The Surgeon must not deceive himself with the belief that in these cases of wound of cornea, with displaced lens, the administration of mercury can avert destructive inflammation. The efficacy of mercury in controlling the effusion of lymph in non-traumatic iritis, arises from the fact of there being, in that case, no foreign body, which a displaced lens really is, pressing against and irritating the iris. *Traumatic iritis*, set up by a displaced lens, is wholly beyond the powers of mercury, and its administration can only do harm, by lowering the patient's reparative power, and so unfitting him to recover from the operation, should removal of the lens be ultimately resorted to.

Rheumatic Iritis.

Rheumatic inflammation of the iris assumes either an *acute* or a *chronic* character. In the former case, the attack can usually be traced to exposure to cold wind or damp, when the body has been exhausted by fatigue or greatly overheated.

According to the nervous susceptibility of the patient, the onset of an attack of rheumatic iritis will be attended either by dull pain in and around the eyeball, or by acute neuralgia throughout the first division of the fifth nerve, extending even to the second and third divisions.

When the attack is severe, there is usually a good deal of intolerance of light, and lacrymation. The vascular zone is not well marked, on account of its being lost in the general injection of the whole sclerotic, which assumes the purplish tint I have described as characterising sclerotic inflammation.

Rheumatic iritis is almost always attended with some slight haziness of the cornea, and in this respect it differs remarkably from the syphilitic form, which, even in the most severe cases, often leaves the cornea perfectly clear. The morbid changes in the iris itself are sometimes so slightly marked as to escape an unpractised or a careless observer; so that it is not until the inflammation has subsided, and the cornea has become quite clear, that the still-existing impairment of sight causes a more careful scrutiny of the pupil to be made, and then (too late) inflammatory exudation into its area, and adhesion of its margin, are found to have taken place.

In the more acute form of rheumatic inflammation, the veins of the iris may be traced on various parts of its surface, as delicate red lines, diverging from the edge of the pupil to the periphery of the iris. I need hardly say that these fine vessels cannot be traced if there exists any considerable haziness of the cornea.

The pupil is contracted, more or less irregular, and as the inflammation goes on, this irregularity becomes more marked, in consequence of effusion of lymph* taking place between the edge of the pupil and the capsule of the lens. The insidious manner in which this fibrinous effusion occurs affords a marked contrast to the rapidity with which large masses of yellow or reddish-yellow lymph show themselves on the edge of the pupil in syphilitic iritis.

I have already noticed the neuralgia throughout the region supplied by the ophthalmic division of the fifth nerve, which attends an acute attack of rheumatic iritis. There is also very frequently considerable febrile disturbance, the urine being loaded with lithates.

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* In describing iritis, I shall frequently have occasion to speak of that exudation from its vessels which constitutes the most serious feature of the disease, by forming adhesions between the pupillary margin and the capsule of the lens, or wholly blocking up the area of the pupil with opaque membrane. Whether this *exudatum* becomes itself converted into fibrous tissue, or whether it only influences the cells of the tissue among which it is effused, and causes new cells to be developed from those already existing, is a physiological question which can hardly be decided. I have used the term "lymph" to describe this *exudatum*, because the word is familiar to all my readers, and is sanctioned by long usage.

The majority of cases do not present such acute symptoms as those just described, but pursue a more chronic course. The injection of the sclerotic being less general, the vascular zone around the cornea is better marked; there is little, if any, intolerance of light or lacrymation, and instead of severe neuralgia in the fifth nerve, there is only a dull aching pain in and around the eyeball.

But, whether the iritis be acute or chronic, there is still the same danger of effusion of lymph into the area of the pupil, and this danger is, as I have said, all the greater on account of the gradual and insidious manner in which the effusion takes place. To check this is the main object to be kept in view.

Treatment. If the early stage of acute rheumatic iritis be attended with severe neuralgia, as is frequently the case, the treatment will be much the same as that which I have described in Chapter III., as suitable to acute inflammation of the sclerotic. In some patients iodide of potassium, in others colchicum, will be of most service; while some cases, characterised by visible enlargement of the veins of the iris, yield to turpentine. I have usually given the Chian turpentine in substance, as pills, four grains three times a day. The condition of the pupil must be carefully scrutinised from day to day; and if it be found irregular and angular, or if any brownish tags appear to be forming at its edge, mercury must at once be given. Two grains of calomel, with a third or half a grain of opium, may be taken night and morning; and should any tenderness of the gums begin, the quantity ought at once to be diminished; for if salivation be allowed to occur, the neuralgia is almost certain to return, and the mercury, which in small doses was so beneficial, begins at once to exert its depressing influence. In delicate subjects it is often very useful to give a dose of bark,—Battley's liquor cinchonæ or quinine,—in the middle of the day, even during the time the mercury is being taken.

It is almost impossible to lay down precise rules about diet. It should not be *low*,—that is to say, innutritious,—but light and easily digestible; soup, bread-and-milk, farinaceous food of various kinds, with or without a proportion of meat, according to the patient's digestive powers and previous habits. Stimulants should be given only in such quantities as may be necessary to sustain the circulating forces. Feeble and depressible persons may require a certain amount of dry wine, or diluted spirit, while those addicted to habitual indulgence may only eliminate the rheumatic poison which they have stored up in their blood, by abstinence from the alcohol and sugar they have so long abused.

Occasional steaming of the eye over hot water is the most soothing local application, and where neuralgia is present, is preferable to fomentation by means of wetted compresses.

Leeches to the temples may occasionally be found useful at the onset of an acute attack; but where neuralgia exists they commonly do harm, and they should never be applied to feeble and depressible subjects, or those liable to erysipelas. Blisters also have the disadvantage of exasperating neuralgia. They are, however, very serviceable in the chronic form which often succeeds the acute attack, and they certainly aid in removing that haziness of the cornea, which, if not promptly dispersed, is apt to become permanent.

Syphilitic Iritis.

Inflammation of the iris originating in syphilis is very frequently associated with other forms of secondary or tertiary disease, especially with eruptions on the skin. It is by far the most marked kind of iritis, and is characterised by a tendency to rapid and abundant inflammatory exudation on the iris, especially about the edge of the pupil, in which situation yellow, reddish-yellow, or nearly red nodules sometimes attain to such a size as almost to close up the pupillary area.*

The cornea is either clear, or marked throughout its lower half by very minute dots, of a pale buff tint. These dots are as small as if pricked in with the point of a pin, and are so closely set together as to suggest to a superficial observer the idea of a faint cloudy haze. It often happens, however, that even these minute dots are wholly absent, and the cornea, during an acute attack of iritis, remains perfectly transparent.

There is always a vascular zone in the sclerotic, but not that generally diffused redness of the eyeball so frequently present in rheumatic iritis. Neither, as a rule, is there intolerance of light, which is one of the most marked symptoms of the rheumatic form.

Irides which have naturally a bluish tint, when attacked with syphilitic inflammation, appear more or less green. This is caused by the presence of yellow albumen in the aqueous humour, the admixture of the yellow and blue forming, of course, a green tint. This fact may be demonstrated in some of those old cases in which chronic iritis has attacked an eye again and again, until sight has been lost, nearly all the tissues having undergone a morbid change. If in such a case the cornea be carefully punctured with a broad needle, and the fluid of the anterior chamber caught in a spoon, the application of heat will at once show the presence of albumen; and if the iris have been originally bluish, that colour will be restored as soon as the last drop of the yellow fluid has drained away from the anterior chamber.

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* In Sichel's *Iconographie* (pl. xiii. fig. 5) is a good representation of a mass of lymph, reddened with vessels, at the edge of the pupil.

When a patient has syphilitic iritis for the first time, it may attack both eyes together, or may be limited to one eye. When relapses occur, the inflammation usually affects the right and left eye alternately; and these attacks may come on without the patient having contracted any fresh primary disease.

Syphilitic iritis is so much modified by the condition of the patient, that the Surgeon must take care not to form to himself any arbitrary idea of the appearances, or expect to find in every case the strongly-marked and unmistakable proofs afforded by large nodules of exudation around the pupil. In fact, iritis may exist to such an extent as to produce serious and permanent obstruction to the pupil, without any development of these nodules. In some cases, the lymph is uniformly distributed around the margin of the pupil, which then assumes a thickened ring-like appearance, the rest of the iris exhibiting little, if any, deviation from its healthy aspect. The loss of its mobility, however, is always well marked, even in the slighter cases; and, indeed, the sluggishness or total immobility of the pupil, when exposed to light, is one of the most valuable diagnostic signs of iritis in its early stage.*

Occasionally the nodules of lymph, instead of appearing on the edge of the pupil, are situated on the greater circle of the iris, in the reëntering angle formed between it and the cornea. Such cases are comparatively rare.

In every case of iritis the Surgeon should most carefully examine the area of the pupil, to determine whether it be or be not overspread with lymph. This sometimes exists merely as a very thin film, which may escape detection, unless light be concentrated upon it by means of a lens of short focus. Such a film, however, if not speedily removed by proper treatment, will rapidly become thickened by fresh deposits, and, growing more and more opaque month by month, will eventually form a serious obstacle to the transmission of light.

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* I cannot point out any really good representation of iritis in its early stage. Indeed, it is hardly possible for an artist to convey a true notion of the delicate changes in form and colour which characterise the disease at that period.

The so-called "closure of the pupil," justly regarded as the most serious termination of unchecked iritis, is caused partly by the nodules of lymph which are thrown out upon the margin of the pupil, and unite it to the capsule of the lens (*synechia posterior*), and partly by fluid exudation of the same inflammatory kind, which overspreads that portion of the capsule corresponding to the pupillary area. This exuded fluid, as it solidifies, forms organised connexions with the nodular deposits on the edge of the pupil, and eventually, by its contraction, draws the margin of the pupil together, and permanently blocks up its greatly diminished space with a tough, firm, and opaque membrane.*

Treatment. From what has been said, it will be seen that the leading principle in the treatment of syphilitic iritis consists in procuring as quickly as possible the absorption of the lymph which has been effused in and around the pupil. To effect this, the most powerful agent is *mercury.* But when we consider the variety of constitution in patients attacked with syphilitic iritis, the impaired state of general health they frequently exhibit, in consequence of venereal taint, and the period at which the iritis sometimes occurs,—namely, while they are only just recovering from the debilitating effects of salivation,—it is evident that, in a treatise like the present, little more can be done than to indicate the outlines of treatment, and that the judgment and tact of the Surgeon must be brought to the careful study of each individual case.

When a recent case of syphilitic iritis comes before us in a patient of good general power, we may at once order two grains of calomel, with a third or half a grain of opium, to be taken night and morning; first clearing the bowels, if necessary, by a rapidly acting aperient. In private practice, where our patients are not necessarily exposed to the weather, the calomel may be given more frequently, but in smaller doses; a grain, for instance, every four hours, combined with just enough opium to prevent purging.

The effect of the mercury must be judged of by the state of the eye, not by the soreness of the gums. Indeed, I look upon soreness of the mouth as a condition to be always avoided, if possible;

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* This form of obstruction is sometimes called "spurious cataract;" but the term is manifestly improper, as the word 'cataract' should be strictly limited to opacity of the lens itself.

never to be willingly produced, as is so often the case. As soon, therefore, as the gums begin to be at all affected, the calomel is to be given less frequently; the absorption of the lymph in the pupil being the test of the mercury having been effectual. The two-grain pills may be taken once instead of twice a day; the grain every four hours changed to the same quantity every twelve hours, and then taken at twice that interval of time.

A patient sometimes comes before us with recent iritis, which has come on while he was actually under the influence of mercury, given for venereal disease. What are we to do in such a case? Perhaps we shall find that the patient, while taking the mercury, has been kept on very low diet, deprived of all animal food, and restricted to "slops." In that case, the mere change to a better diet,—animal food and other nutriment being given, with a moderate quantity of the stimulant to which he has been accustomed,—will often effect a surprising change, and stop the further effusion of lymph; while iodide of potassium, with bark, or, if the patient be extremely depressed by the mercury, even quinine alone, will at once cause absorption of the lymph to begin.

Or a directly opposite state of things may exist. The patient may have sought relief from the depressing effects of too much mercury by indulging in stimulants, and in this way may have induced an irritable condition of the circulation, quite incompatible with a due interchange of material in the system. Restriction of stimulants within due bounds will be as essential in this case as their use had been in the case of the ill-nourished and anæmic patient.

If a patient has been attacked with syphilitic iritis while under the depressing influence of too much mercury, given for general syphilis, and it has been found necessary to suspend the use of the mercury until tonics and a change of diet should have improved his general health, we shall often find, that by resuming the mercury in *small* doses, while at the same time we continue the tonics, the iritis will yield, although it may have resisted the large doses which had been given under circumstances of over-stimulation or deficient nutrition.

Turpentine was recommended by Carmichael, as a substitute for mercury, in those cases to which I have alluded as unsuitable for the administration of the latter, on account of general debility. I have, however, found more benefit from the use of iodide of potassium, or even of very small doses of mercury, combined with tonics and improved diet, as above described. I have sometimes found turpentine of service in cases of rheumatic iritis, characterised by hyperæmia of the iris and sclerotic, but unattended with much disposition to effusion of lymph.

Syphilitic iritis has often a tendency to become *chronic;* each relapse being characterised by a slight sclerotic zone, a yellowness of the aqueous fluid, giving a greenish tint to blue irides; general dimness of sight, and a slight filmy deposit in the area of the pupil. This chronic form is chiefly found in patients who are the subjects of tertiary syphilis, and a carefully regulated course of iron often affords the best means of treatment.

In describing iritis, I have hitherto spoken only of those changes which are visible under ordinary observation; but the ophthalmoscope has demonstrated to us, what we formerly could only guess at, namely, that in so-called iritis the *retina* is often more seriously affected than even the iris itself.

To attempt to examine the retina during an acute attack of iritis, would be not only useless, but injurious; for the lymph deposited in the pupil, and perhaps in the vitreous humour also, would prevent any clear view of the parts behind; while the glare of light would be almost certain to increase the already existing hyperæmia of the organ. We often, however, have the opportunity of examining the retina after all inflammation has passed away, leaving the cornea, lens, and vitreous humour transparent. We can then fully appreciate the close connexion between syphilitic inflammation of the iris and of the retina, and understand why it is, that in cases of so-called "iritis," the dimness of vision is often out of all proportion to the changes in and about the iris.

One of the sequelæ of iritis (I use the word 'iritis' in its more extended sense), is a cloudy condition of the vitreous humour, in which filaments and shreds, varying in shape and size, float freely in every direction. These bodies, although really whitish, of course appear black, or nearly so, when seen against the illuminated retina. They appear to be inflammatory deposits, intermixed in some instances with broken-up hyaloid membrane.

The retina presents still more varied marks of syphilitic inflammation. The optic nerve appears greatly enlarged, irregular in its outline, and of a homogeneous whitish texture. It is probable that in such cases we do not see the real tissue of the optic nerve, but only a layer of lymph overlying it. The vessels emerging from the nerve are small and shrunken. Large, irregular, white patches are scattered over the retina, in some cases involving the greater part of its surface. These appear to be portions of the nervous coat infiltrated with lymph, and no longer permeated by vessels. Patches and dots of black pigment are frequently seen scattered over and among these opaque portions of the retina.

Hence, it appears that syphilitic inflammation, when it attacks the eye, may exhibit its chief phenomena in the iris, involving the retina only to a very slight extent; or both structures may be equally affected; or lastly, the retina may suffer in such a degree as almost to become useless, while the iris shows little, if any, sign of inflammation, and the patient is hardly aware of the eye being the subject of disease, until vision is found to be almost lost.

Syphilitic Iritis in Infants.

Iritis is one of the rarest forms in which hereditary syphilis manifests itself during infancy. The careful researches of Mr. Hutchinson,* however, have shown that it is not quite so rare as has been supposed; and it probably often escapes notice on account, as he observes, of the very small amount of local symptoms which it causes, coupled with the fact that infants usually keep their eyes shut. Within the last ten years I have seen but five or six cases of syphilitic iritis in infants, among the many thousands of patients whom I have treated at the Moorfields Hospital. Some of these infants presented the stunted and unhealthy aspect which usually accompanies inherited syphilis; but two, whose cases I have elsewhere reported in full,† were well-grown children.

One of the most striking peculiarities of iritis in infants is the very slight development of a sclerotic zone, that unfailing sign of iritis in the adult. Indeed, in some of the cases I have seen, sclerotic redness could hardly be said to exist.

The infant at the age of from two to ten months is attacked with copper-coloured eruption; perhaps also with mucous tubercles about the genitals, aphthæ in the mouth, and "snuffles." The eyelashes fall off, and sometimes the nails also are partially detached. In some cases the skin presents a peculiar dusky tint, and is wrinkled and scurfy.

The lymph does not assume the form of solid tubercular masses on the edge of the pupil, as in the adult, but either fills the area of the pupil, as a pale yellow semifluid mass, or sinks down to the bottom of the anterior chamber, like ordinary *hypopyon.* In one of the cases I saw, the lower half of the iris was completely hidden by a nodular mass of lymph, of a pale buff tint, which came into contact with the cornea, and completely filled the anterior chamber as high up as the middle of the pupil.* In another case, the effused lymph,—for such it seemed to be,—was scattered all over the lower half of the iris in the form of little, grayish-white, semi-transparent granules, like grains of coarse sand. The pupil was fringed with the same kind of deposit.

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* The result of Mr. Hutchinson's observations is given in the 1st vol. of the *Ophthalmic Hospital Reports*, 1858. This essay, *On the different forms of Inflammation of the Eye consequent on inherited Syphilis*, affords, as far as I know, the best account of the subject which has yet appeared.

† *A Guide to the Practical Study of Diseases of the Eye*, 2d edition, 1859, p. 149.

Treatment. Before speaking of any special medicines for infants affected with syphilitic iritis, I would remark on the absolute necessity for their being suckled, and not brought up by hand. The milk of a healthy wet-nurse would of course be infinitely preferable to that of an infected mother; but in the lower classes of society, among whom this disease is almost exclusively met with, the services of a wet-nurse can hardly be obtained.

Mercury should at once be given, either in the form of hydr. c. cretâ or calomel. The former of these substances is so uncertain in its chemical composition, that, unless its genuineness can be ascertained, calomel is to be preferred. Two grains of hydr. c. cretâ, or from a quarter of a grain to half a grain of calomel, may be given night and morning.

The effect of the medicine must be carefully watched from day to day, and as soon as the lymph begins to disappear from the eye, and the cutaneous eruption to fade, the dose may be gradually diminished; but it will often be necessary for the mercurial treatment to be continued, in a modified form, for several weeks. Weakly infants will be much benefited by taking five minims of Battley's liquor cinchonæ twice a-day in a little milk. Provided the child sucks and digests well, the mercury does unmixed good, and, by counteracting the venereal poison, not only frees the skin from the specific eruption, but imparts to it a healthy hue, instead of the peculiar dusky colour which was originally so evident.

I cannot conclude this subject without noticing the extraordinary treatment inculcated by Walker in his *Oculist's Vade-Mecum,* a work which, from its recent date (1843), may still influence practice. He advises leeches to the lids, as being " useful in most cases, in such numbers as are suitable to the age and constitution of the child;" and says, that "purgatives, and in some instances even nauseants, should be freely administered." His dose of calomel for an infant seven months old was two grains twice a-day, during five weeks, and then once a-day for two months longer; and at the end of that time the dose was resumed night and morning. The final report of the case states, that "no alteration in the eye was observed after this time, the pupil remaining permanently contracted, and the capsule opaque." Nothing could more completely demonstrate the inutility of these monstrous doses of mercury than this result.

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* *Guide to the Practical Study of Diseases of the Eye,* 2d edition, 1859, p. 149, fig. *a.*

How any number of leeches can be "suitable to the age and constitution" of an infant only a few months old, and infected with the poison of syphilis, I cannot conceive; nor is the abstraction of blood from the skin of the eyelids likely to exert much influence on a structure like the iris, which derives its supply of blood from a source so deeply seated as the ophthalmic artery.

To "nauseate" a weakly child, and thus to impair its power of taking food at such a critical time, seems equally irrational with the rest of the treatment.

SCROFULOUS IRITIS.

Most of the patients in whom I have observed this form of iritis have been between five and fifteen years of age, and all have shown signs of a scrofulous constitution.

The iritis presented a resemblance to the syphilitic inflammation of adults, in respect of the abundant exudation which took place on the iris, and in the anterior chamber; but in the severer cases of the scrofulous form there was a still greater disposition to enlargement of the veins of the iris, and infiltration of its whole tissue, than is usually met with in syphilitic cases. In scrofulous iritis the large masses of yellow deposit are not so frequently limited to the margin of the pupil, but often appear midway between the pupil and the outer circle of the iris, or at the latter point, just in the angle between the iris and the cornea. Slight bleeding not unfrequently takes place into the anterior chamber, from giving way of the distended veins of the iris.

The cornea usually remains clear, but it sometimes presents a slight degree of mottled opacity, especially towards the lower part.

Treatment. In the treatment of scrofulous iritis, as in all scrofulous affections, the diet and general mode of life deserve the utmost attention. Abundance—not excess—of animal food; warm clothing; pure air,—sea-air, if attainable,—are all important adjuncts to the medical treatment. Cod-liver oil is often of great service, and may be taken in combination with the other remedies. The bowels are usually irregular, and the appetite bad; and a mild aperient will be occasionally required; but care should be taken to avoid drastic purgatives, such as scammony and jalap.

When there is abundant inflammatory exudation into the anterior chamber, without much enlargement of the veins of the iris, or development of a sclerotic zone, half a grain or a grain of calomel at night, with two or three grains of quinine, or ten or twelve minims of liquor cinchonæ, taken an hour or so after a meal, will often produce a rapid absorption of the effused fluid. Where the exudation assumes the solid form, infiltrating a considerable portion of the iris, or appearing at its inner or outer circle as large yellow nodules, reddened with vessels, the iodide of iron is often useful, both in promoting the absorption of the deposit, and in diminishing the vascularity of the iris itself.

All stimulating applications must be avoided; nor, indeed, is any local treatment of service.

Gonorrhœal and Arthritic Iritis.

I have never been able to trace an attack of iritis as a result of simple gonorrhœa; although, of course, it may often happen that a patient is attacked with ordinary rheumatic iritis within a short period of his having had urethral discharge. Gonorrhœa is, unfortunately, so common, that were there any definite form of iritis dependent upon it, so marked a sequela of the discharge would be constantly brought under our notice.

Neither have I seen cases of iritis which I could refer to gout. The descriptions of "arthritic iritis" one meets with in books are chiefly taken from German writers, especially Beer and his contemporaries, whose account of the disease, which they term *gouty* inflammation, more nearly answers to that of chronic glaucoma. The ash-coloured ring in the sclerotic, immediately surrounding the cornea, described by German writers as the *arthritic* ring or circle, and regarded by them as diagnostic of arthritic iritis, is not peculiar to any special form of inflammation. Its presence merely depends upon the anatomical arrangement of the adjacent portions of the sclerotic and cornea. When these two structures are united obliquely, so that a considerable extent of the sclerotic is overlapped by the cornea, the vessels of the former do not appear to advance so near to the iris as in other cases; and hence a narrow ring, of a paler tint, is interposed between the dense plexus of vessels forming the sclerotic zone and the iris itself.

USE OF ATROPINE.

This substance has so completely superseded the more bulky drug belladonna, of which it forms the active principle, that the latter term may be discarded when speaking of the employment of "mydriatics" in diseases of the eye. Those accustomed to regard the use of atropine as a matter of course at *every* stage of iritis, will be surprised to find the subject postponed to the end of a section treating of that disease. Indeed, the remarks I made several years ago* respecting atropine have been regarded as little short of heretical by many whose opinion I respect and value; and perhaps—in my anxiety to protest against what I had long felt to be a mere routine employment of belladonna—I expressed myself in a manner which led hasty readers to suppose I was not fully sensible to its real value. Many years ago, when in the habit of watching the practice at Moorfields, I observed the uniformity with which every patient attacked with iritis, whether acute or chronic, was, on his first attendance, bedaubed with the ext. belladonnæ all round the affected eye; and I saw in how many instances the drug was perfectly inert, either on account of the inflamed and infiltrated condition of the iris, or the firm adhesions it had formed to the capsule of the lens. Subsequently, when engaged in treating patients, both in public and private, I was struck with the fact that, whenever a case came before me of extensive synechia posterior, or even of closed pupil, from bygone iritis, the history of the treatment almost invariably included the application of belladonna. It appeared to me that too much was expected from belladonna, and too little from mercury judiciously administered; and, of late, German writers have spoken of "mydriatics" as if these substances were almost able of themselves to combat iritis.

In the present work I have mentioned the invaluable properties of atropine too often for any attentive reader to suppose that I do not appreciate it as it deserves. In fact, without the use of this, or some similar mydriatic, it would be useless for any Surgeon to attempt the study and treatment of ophthalmic diseases. Inert as atropine is during the acute stage of iritis, it may be advantageously used when the inflammation has subsided, and the iris is beginning to regain its contractility; it will then be the means of enabling us to ascertain the extent to which synechia has occurred, perhaps even of removing some of the slighter and more recently formed adhesions, and it will allow of our effectually using the ophthalmoscope, so as to discover whether any disease exists in the vitreous body or the retina. But we must never forget that diminution or occlusion of the pupillary area in iritis is not the result of spasm of a sphincter muscle, the contractions of which are to be controlled by atropine. The real cause of closure is totally different from this; lymph is poured out from the surface of the iris upon the front part of the capsule, where it corresponds to the aperture of the pupil; and if this effused lymph be not quickly removed by absorption, it becomes permanent, and forms a membrane, stretching across and blocking up the opening. This membrane gradually contracts, and, in doing so, draws together the edges of the pupil, until its aperture is either wholly closed, or is reduced to a mere pin-hole, quite inadequate, from its membranous obstructions, to allow of useful vision. However much, therefore, we may employ atropine during the sub-acute or chronic stages of iritis, we must always regard it as an adjunct to more active agents, and never forget that it is the exudation of lymph which, in every case of iritis, constitutes the real danger to vision.

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* See *Guide to the Practical Study*, &c. 1st edition, 1855, p. 138.

SEQUELÆ OF IRITIS.

Besides the changes already mentioned as resulting from iritis, such as obstruction, or closure of the pupil, the inflammation is sometimes followed by degeneration of structure, which more or less involves the whole tissue of the iris.

Chronic iritis, for instance, in a cachectic subject, especially if the disease has been allowed to run on unchecked, is apt to induce a permanent thickening of the iris, all appearance of its normal fibrous tissue being lost, and the veins of the part becoming enlarged and irregularly dilated.

On the other hand, the constant pressure of a calcified lens, which has become thrust forward against the iris, will sometimes induce such wasting of its tissue, that the uvea wholly disappears, and the thin web of iris which remains allows the chalky-white lens to be distinctly seen through it.

Another consequence of iritis is the distension of the iris into pouches, which are formed in the following way. An attack of syphilitic iritis, left to itself, or badly treated, causes the whole margin of the iris to adhere to the capsule of the lens; the pupillary area being, at the same time, very small, and filled up with opaque deposit. All communication between the anterior and the posterior aqueous chamber is cut off; and the aqueous fluid secreted in the latter cavity, not being able to pass through the pupil into the anterior chamber, accumulates behind the iris, and gradually distends and presses it forwards; the pupillary margin meantime being prevented from advancing with the rest of the iris, in consequence of its union with the capsule.

If the uveal surface, except just at the edge of the pupil, be free from adhesion, the whole anterior surface of the iris forms one convex mass, with a deep depression at its centre, in the position of the closed pupil; but if the uvea be here and there adherent to the capsule of the lens, the iris at those spots remains retracted, like the pupil, while intervening portions of iris are thrown into a series of pouches, which may almost, or quite, touch the cornea. These pouched portions of iris lose their fibrous appearance, and have a dark slaty tint.

Vision, in such cases, is reduced to mere perception of light; but, provided the retina be sound, excellent sight can often be restored by means of a carefully planned and skilfully executed artificial pupil.

In cases of long-continued iritis, combined with disease of the choroid, and of the anterior portion of the sclerotic, the iris not only becomes united to the capsule, and bulges forwards in the manner just described, but the fluid secreted in the posterior aqueous chamber, continuing to accumulate, exerts pressure on the anterior portion of the sclerotic, and stretches its weakened tissue. This gradually yields, and forms a *staphyloma scleroticæ*, a tense bluish-black prominence, streaked with the widely separated whitish lines of the sclerotic fibres. At first, while the prominence is small, it is usually situated at the upper part of the globe, just behind the cornea; but the distension may go on until the whole of the sclerotic, between the line of insertion of the recti muscles and the margin of the cornea, forms one bulging lead-coloured staphyloma.

Staphyloma scleroticæ is always a sign of the deeper tissues of the eye having suffered from disease, and, if developed to any considerable extent, would contraindicate the operations for artificial pupil or cataract.

Cysts of the iris. In very rare cases a punctured wound of the iris, near its ciliary attachment, has been followed by a cyst-like expansion of its substance, in consequence, apparently, of the fluid of the posterior aqueous chamber finding its way between the uvea and the fibrous tissue of the iris.

These cysts present a dark slaty tint, which nearly approaches to black when their walls become very thin. The treatment of these cases is often extremely troublesome, on account of the readiness with which the expanded iris-tissue reunites after being lacerated. When the lens is *in situ*, and transparent, the difficulty is greatly increased.*

OPERATIONS ON THE IRIS FOR ARTIFICIAL PUPIL.

Many of the diseases and injuries affecting the iris and cornea, described in the foregoing chapters, produce complete closure of the pupil, while others either cause it to become displaced from its natural position, or leave it more or less completely hidden behind a dense corneal opacity.

All operations for the relief of such obstructions or mal-positions of the pupil may be suitably described in this place; while the operation on the iris, which has recently been proposed as a cure for *glaucoma*, must be deferred until that disease has been considered.

The term *Artificial Pupil* must be understood to include not only the formation of a new aperture in the iris, when the portion forming the natural pupil has prolapsed through a breach in the cornea, but also the reopening or the enlargement of the natural pupil when obstructed by inflammatory deposit; or the displacement, towards a transparent part of the cornea, of a pupil which has become overshadowed and hidden behind a dense corneal opacity.

Before attempting any form of operation for artificial pupil, the Surgeon must make himself thoroughly acquainted with the history of the case, and especially ascertain for himself the following conditions:

First, whether the eye perceives light: mere obliteration of pupil will not deprive the eye of this power, provided the retina be sound; for we know, by personal experiment, that even the thickness of our closed lids does not prevent our noticing the shadow of a hand passing between our eye and the window.

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* See a case reported at length in my *Guide to the Study of Diseases of the Eye*, 2d edition, 1859, p. 408.

Secondly, the presence or absence of the lens must, as far as possible, be ascertained, and, if present, whether it is transparent or opaque.

Thirdly, the cornea must be carefully examined, as to its degree of transparency.

Fourthly, the state of the iris itself must be noticed. The existence of chronic iritis would induce the Surgeon to defer the operation until the inflammation had ceased. A thickened iris, in which all trace of its peculiar fibrous structure is lost, is specially unfitted for an operation, as it breaks away under the slightest traction, and, if cut, the wound does not gape, so as to form a permanent aperture.

As a rule, it is not desirable to operate for artificial pupil when the other eye is perfect.

The principle, not to inflict unnecessary injury on the parts operated upon, which holds good of every surgical operation, applies with peculiar force to that for an artificial pupil; for very often the portion of transparent cornea is very small, and a needlessly large cicatrix may seriously diminish the patient's field of vision.

Generally speaking, a small artificial pupil is more useful than a large one ; that is to say, if it can be made in such a position that all the cornea in front of it is transparent. Sometimes, however, the pupil has to be drawn from behind an opaque corneal cicatrix; and in that case it is only by making a large aperture that a sufficient portion of it can be rendered available.

Inasmuch as the natural pupil is placed nearly in the centre of the iris, it would follow that a similar position must be the most suitable for an artificial aperture. Various considerations, however, may induce the Surgeon to select a more peripheral situation ; but he should always strive to approach the centre of the iris, as far as circumstances will allow.

Peculiar care is required in the examination of those cases, frequently brought under our notice, in which the greater part of the cornea appears converted into a more or less prominent, densely opaque, white cicatrix, after severe purulent or gonorrhœal ophthalmia. The patient may have good perception of light, and there may be an appearance of a narrow strip of semitransparent cornea adjacent to the sclerotic, suggesting the possibility of an artificial pupil being made. And yet the appearance of true corneal tissue may be altogether deceptive.

When the whole cornea has been destroyed by ulceration, as in severe purulent ophthalmia of infants, or the gonorrhœal ophthalmia of adults, the iris is for a time laid bare; but very soon exudation takes place on its surface, until such a thickness of fibrous tissue is deposited as to form the prominence known as *staphyloma.* The greater part of this fibrous coating of the iris eventually becomes white and opaque, and traversed by ramifying vessels; but the marginal portion of the iris is covered by a semitransparent tissue, united, perhaps, to a very narrow ring of true cornea, just that portion immediately connected with the sclerotic. No space, however, exists between this semitransparent tissue and the fibres of the iris; and any attempt, therefore, to make an artificial pupil in this situation would only end in disappointment.

The different modes of making an artificial pupil may be classed under four heads: *laceration*, *incision*, *excision*, and *ligature.*

1. *Laceration.* This consists in tearing away a certain portion of the iris from its ciliary attachment, and is so unscientific, clumsy, and ineffectual an operation, that I should not even mention it, were it not sanctioned and recommended by many continental authorities in ophthalmic surgery. Near the margin of the cornea an incision is made, through which a sharp hook is introduced, and then carried across to the opposite side of the anterior chamber. Here the hook is stuck into the iris, and then drawn back towards the corneal wound. This traction causes the ciliary attachment of the iris to give way; and when the iris has been separated to the extent desired, the hook is detached and withdrawn from the eye.

An artificial pupil of this kind involves almost all the faults it is possible to include in one operation. Its position, opposite to the margin of the cornea, is the worst that could possibly be chosen; the size of the rent cannot be accurately limited; the vessels and nerves of the iris are torn just where they are largest; the great circular vein, surrounding the iris, pours out a quantity of blood, which partly or wholly fills the anterior chamber, and is not readily absorbed; if the lens be present, there is considerable risk of wounding it with the hook, which, in its withdrawal, is frequently caught in the corneal incision. It is to be hoped that this operation will speedily be consigned to the limbo of obsolete surgery.

2. *Incision.* This is the oldest form of operation for artificial pupil, being that employed by Cheselden in a case commonly spoken of as the first in which an artificial pupil was made. The operation is founded on the elasticity of the fibres of the iris, which causes them to retract when cut across, so as to leave an aperture for the transmission of light to the retina. Hence it will be seen that the operation is likely to succeed in proportion to the state of tension

and retractile power of the iris, and will be inadmissible in those cases of closure of the pupil resulting from chronic iritis, or any other disease of the iris which has caused softening and degeneration of its tissue. The operation by incision would also be contra-indicated if the lens were present, as injury to it must almost inevitably follow the penetration of the iris by a cutting instrument.

The operation, therefore, is much restricted in its application, and is almost confined to those cases in which, after extraction of a cataract, there has been prolapsus iridis to such an extent as wholly to obliterate the pupil, the fibres of the iris remaining on the stretch in consequence of so large a portion becoming healed into, and confounded with, the corneal cicatrix.

The incision is made either with a cutting-needle or a fine narrow knife, or else with scissors. The needle or knife is passed into the anterior chamber close to the edge of the cornea, and when the point has been carried a little beyond the middle of the iris, the cutting edge is turned backwards, the point is made to penetrate the iris, and its fibres are divided to such an extent as may be desired. The needle or knife is then rotated into its original position and withdrawn.

Maunoir* modified the operation by using scissors for dividing the iris; but of course they required a large corneal wound for their introduction, and neither the linear nor the V-shaped incision which he recommended was found by any means easy to accomplish when the iris had become flaccid after the escape of all the aqueous humour.

If scissors are employed at all, the cannula scissors, invented by Wilde, would be found far more convenient for incising the iris, as they may be so constructed as to cut their own way into the cornea, and fill up the wound they make, so as to retain a good deal of the fluid in the anterior chamber.

In cases where a very narrow strip of cornea alone remains transparent, after sloughing or ulceration throughout the rest of its extent, it becomes of the utmost importance to accomplish the division of the iris with as little injury to the cornea as possible. In such cases I have found the most useful instrument to be a broad needle, cutting on both sides for a short distance from its point.

3. *Excision.* In cases where the pupil had become drawn toge-

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* *Mémoires sur l'Organisation de l'Iris et l'Opération de la Pupille Artificielle*, Paris, 1812.

ther, and its contracted area blocked up with an opaque membrane, in consequence of iritis, the lens being unaffected, the operation of incision, either by the knife or scissors, was contraindicated, since it was hardly possible to puncture the iris with a cutting instrument without wounding the lens. The operation of excision therefore became necessary, which was performed as follows: an opening of sufficient size having been made in the cornea, a forceps was introduced into the anterior chamber; when its branches were opened, a portion of iris was included between them, and, being grasped, was drawn out of the corneal wound, and then cut off with scissors. The objection to this operation was the difficulty of limiting the quantity of iris removed; the pupil was usually very large, and extended almost, if not quite, up to the border of the cornea.

The "blunt hook," invented by Tyrrell, introduced a more delicate and precise mode of operating; and, for special cases, has not been superseded by any subsequent contrivance. It requires only a very small corneal wound for its introduction; and it can be employed without risk in cases where the lens is *in situ* and transparent.

It is specially adapted for the following cases. First, when, after extraction, there has been extensive prolapse of the iris, so as to obliterate all but a very small vestige of the pupil. Secondly, when, in consequence of iritis, the whole pupillary margin has become adherent to the capsule, the peripheral portion of the lens itself remaining transparent. And, lastly, when the iris is perfectly healthy, but the pupil is hidden behind a dense central opacity of the cornea, the rest of the cornea remaining clear.

a. In a case such as I have alluded to under the first head, we will assume the lens to have been extracted through an upward section of the cornea. The artificial enlargement of the pupil would be made in the following manner: the lids being held apart with a spring-wire speculum, the Surgeon steadies the globe by nipping up with a forceps a little fold of the ocular conjunctiva, just above the upper edge of the cornea; he holds in the other hand the broad cutting-needle, which he passes through the lower edge of the cornea, close to its junction with the sclerotic. If the width of the blade be properly proportioned to the size of the hook, a simple puncture will suffice; but if the needle be narrow, its edges may be used to enlarge the wound to a sufficient extent. The needle should now be gently withdrawn; not with a jerk, as such a movement is usually followed by a spirt of aqueous humour, and it is important to retain as much of that fluid as possible. The Surgeon then takes the blunt hook, and passes it in through the corneal wound, the flat side of the hook coming in contact with the iris. The instrument, held in this position, is rapidly passed upwards, until its extremity reaches the small pupillary opening; then the handle is rotated so as to allow of the lower edge of the displaced pupil being firmly caught in the bend of the hook; gentle traction is then made, and at the same time the handle is again rotated in such a manner that the short bent portion faces directly forwards. It is only in this position that the hook can be withdrawn through the corneal wound without catching in it; and it is for the want of attending to this little manœuvre that those who use the blunt hook so frequently find a difficulty in withdrawing it. When the hook, holding the iris, has been fairly brought out of the wound, an assistant, with a pair of fine scissors, snips through the iris, *close* to the hook, if a good portion of iris has been secured; but should the iris have torn, and only a small portion been withdrawn, it may be desirable to cut through it close to the cornea. Sometimes the tissue of the iris is so much softened that it breaks in coming out, and then the Surgeon must use a fine forceps to catch what remains, and so prevent its retracting into the anterior chamber.

Any little shreds of iris that hang in the wound should be returned by means of a little spatula, so that the lips of the wound may come into exact apposition.

The description just given of the mode of using the blunt hook, and of other details in the operation for artificial pupil, will apply to the different modifications subsequently described. The wire speculum, and forceps to steady the globe, will always be found useful, often indispensable. The patient should lie down on a couch; and the best light is usually obtained by the foot of the couch being turned towards the window; the Surgeon standing or sitting behind the patient's head. The use of chloroform will be regulated by circumstances; it is commonly necessary with children, or very intractable patients; but the pain of the operation, when skilfully performed, is so trifling, that patients possessed of self-control can usually dispense with chloroform altogether.

b. The next class of cases in which the blunt hook should be employed is that where iritis has terminated in adhesion between the whole or the greater part of the pupillary margin and the capsule of the lens.

At pp. 751, 2, under the head "Sequelæ of Iritis," I have described such a condition of closed pupil, accompanied by a bulging forward of the iris, in consequence of the pressure of the fluid secreted in the posterior chamber of the aqueous humour. When the whole surface of the uvea has become adherent to the capsule of the lens, these pouch-like dilatations of the iris do not exist. When only the extreme edge of the pupil adheres, the rest of the uveal surface remaining free, the contracted pupillary area, blocked up with opaque membrane, remains fixed, while the iris bulges all round it, so as in some places to touch the cornea. Partial adhesions of the uvea to the capsule give rise to deep grooves, subdividing the iris into separate pouches; the accumulation of fluid behind the iris being unable at these points to thrust it forwards.

When the whole cornea is clear, and the Surgeon can select the position in which to make an artificial pupil, he will find it best to extend it either directly outwards, or directly downwards; and in a case of pouched iris, such as I am now considering, if a depression in the iris exists in either of these directions, he may take advantage of the circumstance to insinuate the cutting-needle and hook between the cornea and iris, without risk of wounding the latter.

When, however, he has succeeded in catching the edge of the pupil, and drawing out a piece of iris, he may perhaps be disappointed to find that he has removed only its fibrous portion, and that the aperture he has made is still blocked up by a layer of uveal pigment, adherent to the anterior capsule. Although in such a case the first operation may have done but little towards restoring sight to the patient, it will be found to have greatly facilitated a second operation, as the fluid which had been pent up in the posterior aqueous chamber can now find its way into the anterior chamber, and, in consequence, the whole iris will lose its pouched appearance, and recede from the cornea. After the slight irritation caused by the first operation has passed off, the cutting-needle may be introduced at a new point of the cornea, the edge of the artificial pupil caught with the blunt hook, and drawn in such a direction as to remove a portion of iris which had never been adherent to the capsule. If the periphery of the lens be transparent, this second operation will at once open a way for the rays of light to pass to the retina.

c. Extensive ulceration at the centre of the cornea, stopping short of actual perforation, may leave a cicatrix so large and opaque as entirely to cover the pupil, restricting the patient's sight to the perception of large objects placed very much out of the line of direct vision. The iris itself, when viewed through the transparent periphery of the cornea, may present a perfectly healthy appearance, and there may be every reason to suppose that the whole globe, with the exception of the cornea, has been unaffected by disease. In such a case, the object of the Surgeon will be to displace the pupil either outwards or downwards, accordingly as he finds the outer or the lower portion of the cornea preferable in respect of transparency. The blunt hook is the most convenient instrument for effecting this displacement, as it does not endanger the lens, which I am supposing to be perfectly healthy. An opening having been made, either at the outer or lower margin of the cornea, in the manner described at p. 756, the free margin of the pupil is to be caught with the hook and drawn out, a larger or smaller piece of iris being cut off according to the size of the corneal opacity beyond which the pupil is to extend.

4. *Ligature.* In spite of every precaution, it is not always possible to limit the size of the pupil, which sometimes opens out to an extent greater than was originally intended. To remedy this inconvenience, Mr. Critchett has recently suggested an operation which he terms "Iriddesis,"[*] and which is applicable to a limited number of other cases of artificial pupil besides that just described; as, for instance, where prolapsus iridis has occurred, and so much of the pupillary margin has been drawn into the cicatrix as to reduce the area of the pupil to a very minute aperture; or where the whole pupil has been displaced towards the extreme edge of the cornea, and there overshadowed by an opacity. A puncture is made through the cornea sufficient for the introduction of a cannula forceps; a small portion of the iris near its ciliary attachment is grasped, drawn out through the wound, and tied there with a very fine silken thread. This transforms the pupil into an elongated slit. Should this aperture be found insufficient, it may afterwards be enlarged by tying a second portion of iris in such a position as to draw the pupil into a triangular form.

The operation by *ligature* has the advantage of leaving the margin of the pupil uninjured; and in some cases it has been found that even a certain amount of dilatation and contraction of the aperture has been maintained.

It is far from my intention, in describing the various operations of ophthalmic surgery, to record all the plans that have been suggested or tried in ancient and modern times. To describe the operations and instruments which artificial pupil alone has called forth, would be to enumerate a long and tedious catalogue of inventions, most of which have been long since abandoned as useless.

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[*] *Iriodesis* or *Iridodesis* would be a more correct word to imply tying (δέσις) of the iris, inasmuch as the genitive of *ῖρις* is *ἴριος* or *ἴριδος*.

After-treatment of an artificial pupil. The various forms of operation I have recommended in the foregoing pages, if skilfully performed, inflict so little injury on the eye, that, provided the parts be in a fit state to undergo the operation,—all inflammation being extinct, and the patient's general health having been properly attended to,—little more than repose of the eye is required to enable the cornea to heal; and when that is effected, the wounded iris soon regains its natural texture and appearance. We are often, however, obliged to operate on an iris which has undergone long-continued and repeated attacks of inflammation. The tissue of such an iris is soft and spongy, and its enlarged vessels, when torn or cut, pour out their blood into the anterior chamber, where it may remain for many weeks, or even months, without being absorbed. On the contrary, when the iris is sound, and the patient's health good, but little blood is effused into the anterior chamber, and that little commonly undergoes absorption in the course of a few days.

After an operation for artificial pupil, *both* eyes should be lightly bandaged, or the lids closed with strips of plaster. On the second or third day the eye may be examined. Should there be much sclerotic redness, or intolerance of light, the operated eye must be again closed for a day or two. In most cases, at the end of a week from the operation, a large eye-shade will be sufficient; but the patient must be warned against too soon exposing the eye to strong light; and if the case be one in which the patient has for several years been limited to perception of light, he must be forbidden to strain his newly regained powers of sight by premature examination of small objects. A pair of tinted glasses should be worn for some time after he has begun to go out of doors.

If the operation has been performed under chloroform, it will not be advisable to give any opiate or narcotic at night; but in excitable patients, who have not taken chloroform, it is sometimes necessary to give some mild narcotic. Twenty-five or thirty minims of tinct. hyoscyami, in camphor-mixture, is what I usually order as a night-draught for an adult, who has not been habitually addicted to the use of opiates. But many patients do not require any thing of the kind. There is no reason for denying the patient a moderate quantity of plain animal food on the day of the operation, as well as on the following days. Nor should stimulants be wholly forbidden to those who are accustomed to their daily use. I need hardly say that a patient who is to spend the first day after the operation in bed, and perhaps the rest of the week in the house, is not to live as freely, and have the same amount of stimulants, as if he were taking daily exercise, and were engaged in active pursuits. But, on the other hand, it is absurd to keep a patient on low diet, and deprived of all accustomed stimulants, because a small puncture has been made in his cornea, and a little bit of his iris removed. Old and feeble persons cannot bear such reduction; and if any considerable quantity of blood has escaped into the anterior chamber, the best way to hasten its absorption is to keep the patient's powers up to a healthy standard, by plain nutritious diet, and just such an amount of stimulants as will maintain the circulation at a proper point of vigour.

It is difficult to conceive how Surgeons who wrote and practised within the last forty years, could have thought it necessary to resort to the depleting and starving treatment we find them recommending as necessary, after the operation for an artificial pupil. Little more than thirty years ago, the late Mr. Guthrie,* in a work professing to teach the operative surgery of the eye, wrote as follows: "As a general rule, the patient should be *bled largely after any of the operations* for the formation of an artificial pupil;" and he goes on to say, that this bleeding is to be to the extent of fourteen ounces, in some instances to twenty-four, or from that to thirty ounces; that if the diminution of pain be only temporary, and after a few hours begins to increase (which, in an irritable or neuralgic patient, it would be quite sure to do, after all this loss of blood), recourse must again be had to bleeding; and that if *this* should not be sufficient to arrest the progress of the disease, it must be immediately treated as a case of iritis, and mercury administered in such a manner as to affect the system as rapidly as possible.

Such was the treatment by which a simple, delicate, and almost painless operation was perverted into a cause of suffering and misery.

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* *Lectures on the Operative Surgery of the Eye*, 2d edition, 1827, p. 510.

CHAPTER V.

DISEASES OF THE CHOROID AND RETINA.

(*Amaurosis—Amblyopia—Impaired Vision—Hebetudo Visûs—Choroiditis—Retinitis.*)

The synonyms at the head of this chapter,—and their number might be greatly multiplied by quoting from the older writers on eye-diseases,—will at once show the difficulty that has always existed in assigning definite terms to those defects of sight which depend upon diseased states of the choroid and retina.

While some writers have classified these diseases *subjectively*, according as they are evidenced to the patient by his own perceptions, and have spoken of "impaired vision," "amblyopia," and "amaurosis;" others have attempted an anatomical arrangement, which before the invention of the ophthalmoscope was purely speculative and arbitrary, and have assumed inflammation of the choroid or retina to be the material *objective* cause of the phenomena.

The ophthalmoscope has already dissipated much of the mystery which formerly surrounded the deeper tissues of the globe, and has enabled us to demonstrate morbid changes, the very existence of which could only be vaguely suspected before the ophthalmoscope was invented. But when we remember how considerable a portion of the visual apparatus is contained within the cranial cavity, there must always remain a large class of defects of sight, which, like other cerebral diseases, can admit only of a theoretical and uncertain diagnosis.

I propose, first of all, to consider certain forms of defective sight, which, although frequently attributed to morbid states of the choroid or retina, cannot be proved by the ophthalmoscope to depend upon structural changes in either of those tissues; and afterwards to describe the morbid appearances which these tissues exhibit, and the subjective phenomena to which they give rise.

Impaired vision. Although, etymologically considered, this term is but a latinised equivalent for *weak sight*, a certain limited meaning has been arbitrarily assigned to it. The term is used, for instance, when persons, who have excellent sight for distant objects, begin to experience a difficulty in observing minute or near objects for any considerable time. Needle-women, tailors, jewellers, watchmakers, &c., are the common subjects of this affection. At first they perfectly see the small objects they are engaged upon; but after a few minutes' application the objects begin to grow indistinct. A moment's closure of the eyes allows of the work being proceeded with; but the objects again become misty, and they altogether disappear, unless the eyes are allowed another interval of rest. At last the work must be wholly laid aside.

A similar difficulty is felt by many persons whose position in life removes them from all mechanical occupations. At an age, commonly ranging from forty to fifty, but, in exceptional cases, at a much earlier or a much later period, they find a difficulty in reading small type, and are conscious of a painful effort in the eyes whenever they make the attempt. By degrees larger type becomes trying, and at length any continuous reading, especially by artificial light, is altogether impossible. Probably the difficulty is at first attributed to disordered digestion, and treated accordingly.

"Congestion of the choroid" was the morbid condition which Tyrrell assumed to exist in these cases; and he sought by constitutional treatment, of various kinds, to remove the supposed cause. His views were very generally adopted by the profession; and before the introduction of the ophthalmoscope we had no means of testing the truth of the theory; while the frequency of dyspepsia and feeble health in the persons most liable to this form of "impaired vision," —needle-women, tailors, copying-clerks, &c.,—afforded plausible grounds for attributing their defect of sight to some constitutional ailment.

Persons who, about the period of life I have indicated, begin to experience a difficulty in reading, will usually be found to be long-sighted, and their power of seeing distant objects is probably quite unimpaired; their complaint, in fact, consists in an inability to maintain the adjustment of the eye for near objects. A low convex glass at once compensates this loss of adjusting power; and patients who have spent years in the fruitless attempt to remove by medical means an assumed "congestion of the choroid," are surprised to find that glasses of twenty-four, thirty, or thirty-five inches focus, enable them at once to read, or pursue their mechanical occupation with ease and comfort.

If some of the very worst cases of so-called "impaired vision,"— such as Tyrrell and others would at once have set down as examples of "congestion of choroid,"—are examined with the ophthalmoscope, the fundus of the eye will be found remarkably pale, and ill supplied with blood; and even a prolonged ophthalmoscopic examination will fail to produce any sign of choroidal congestion.

Whatever be the precise mechanism by which adjustment of the eye to distances is effected, there can, I think, be little doubt that contraction of the ciliary muscle is the first agent in the process. In those animals which have occasion very rapidly to alter the adjustment of their eyes,—namely, birds,*—we not only find the ciliary muscle developed in a very high degree, but there also exists a peculiar vascular organ, the *pecten*, the alternate filling and emptying of which appears to act on the same principle as the filling and emptying of the vessels forming the ciliary processes in the human subject.

When our ciliary muscle contracts, force is applied to the fluid contents of the globe; these being in themselves incompressible, the force acts upon the vessels constituting the ciliary processes, and some of the blood they contain is made to pass out of them. This affords room for the lens to move to such an extent as suffices to adjust the eye to perceive near objects; and as soon as the ciliary muscle ceases to contract, the blood returns back again into the ciliary processes, distends them, and obliges the lens to resume the position it formerly held.†

Persons of feeble muscular power, whose sight had been too long exerted in observing near objects, would be the most likely subjects for failure of activity in the ciliary muscle; and in those not originally defective in muscular energy we might expect to find that a delicate structure like the ciliary muscle would begin to lose its precision of action about the middle period of life.

Whether the theory of adjustment I have just noticed be really the true one or not, there can be no doubt as to the great benefit which convex glasses afford to persons in whom the adjustment is defective. Great care is requisite in selecting glasses of suitable convexity. The lowest powers should first be tried, those for instance of 35 or 30 inches focus, and no higher power should be used than will just enable the patient to read small type, or work at his mechanical employment, without a sense of strain and effort in the eyes.

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* The eye of a hawk, soaring at a great height in the air, is adjusted with such precision to observe distant objects, that a small bird on the ground is watched with the greatest accuracy. When the hawk *stoops* to its prey, and falls rapidly upon it, the adjustment of the eye must be as rapidly altered, until, within a few seconds from the time the stoop began, the hawk can select the very spot of the small bird's body into which to plunge his beak.

† See a paper in the *Lancet* (July 26th, 1851), in which this theory of the adaptation of the eye to distances is discussed by Mr. Rainey.

Of course, while insisting on the great utility of these optical aids to vision, I would not be supposed to recommend their employment in all cases of defective adjusting power, to the exclusion of medical treatment. Patients who, from various causes, have become anæmic and weak, are often affected with loss of power to see near objects. Tonic treatment,—especially the use of iron,—internally, and cold water, applied to the eyes themselves as a *douche*, will often suffice to cure the complaint.

I have seen several very interesting cases of loss of adjusting power as a consequence of *diphtheria*. The patients were all young, ranging between the ages of ten and sixteen. When they appeared to have completely rallied from the disease, it was found that they were quite unable to read any ordinary type. There was no morbid appearance in the eyes themselves, and distant objects could be seen as well as ever. In these cases low convex glasses enabled the patients to read with ease ; but I forbade their use, and ordered small doses of iron, cold-bathing to the eyes night and morning, removal to the sea-side, and avoidance of all attempts to read. In every case perfect recovery of adjusting power for near objects was regained in the course of a few weeks.

Muscæ volitantes. The little threads and spots which, by some persons, especially those who are short-sighted, are seen to float and glide over their field of vision, are very commonly attributed to congestion of the choroid. Tyrrell, for instance, assigns as their cause " a preternatural dilatation of some of the delicate vessels" of the part. It seems strange that any one could overlook the fact that *fixed* bodies,—which dilated vessels of the choroid must be,—if they pressed upon the retina so as to impair its function, would suggest to the patient the idea of *fixed* spots in the field of vision, which could only appear to move when the eyeball itself was set in motion. The spots known as *muscæ volitantes*, on the contrary, change their position whenever the eye is suddenly moved: and when the eye is again fixed, the spots still continue for a time to float about in various directions, eventually appearing to descend, as if sinking in a fluid.

Although it is easy to prove that the appearances known as *muscæ volitantes* are not produced by congested vessels of the choroid, the real nature of the bodies which cast their shadows on the retina has hitherto escaped demonstration. It seems certain, however, that the floating bodies themselves are very small, and move through a limited space, probably near to the retina.

They are most commonly met with in short-sighted subjects, and are quite compatible with life-long continuance of the acute powers of vision which such persons frequently enjoy. They are usually first noticed between the ages of 20 and 30; and when they have begun to attract the patient's attention, they appear rapidly to increase in number. This apparent increase is partly due to the fact that, by anxiously watching them, the patient soon acquires a habit of bringing fresh bodies into focus.

If the eye be turned towards a clear sky or a bright cloud, and then kept steadily fixed, the spots appear to sink slowly downwards, just as filmy particles would sink in a liquid, which had been shaken and then kept at rest. A sudden turn of the eye will again cause the little bodies to disperse for a moment, and when the eye is once more fixed, they slowly descend as before.

So long as the patient steadily concentrates his attention on any external object, the *muscæ* are not seen; but if he accidentally alters the adjustment of his eyes, and catches sight of one of the *muscæ*, the whole field of vision at once becomes crowded with them.

The best way of examining the floating bodies is for the patient to look directly downwards upon the illuminated field of a microscope. They will then be recognised as beaded filaments, variously twisted and bent; sometimes appearing as loose knots of coiled-up fibres entangled together. When thus grouped, they have a grayish colour, but when a single filament is examined, it is seen to be made up of highly refractive globules, varying in form and size. Sometimes a filament may be seen to bend, and again become nearly straight, or to turn in such a manner as to present itself in a foreshortened position. This latter circumstance proves that the bodies float freely in a fluid, and are not situated, as some have supposed, upon the surface of the cornea. This is still further proved by the fact that the blinking of the lids has no effect whatever upon the position of the *muscæ* in the field of vision. If, when the lids are closed, the eyes are turned towards a strong light,—exposed to sunlight, for instance,—the *muscæ* can still be seen, and their movements will be just as free as when they were observed with the eyes open.

There are few phenomena which give rise to more alarm in patient's minds than *muscæ volitantes.* A vague notion that they are the forerunners of amaurosis or cataract is almost universal; and even medical men are apt to confound these *floating* muscæ with the moving cloudy shadows resulting from effusions of blood or lymph within the vitreous humour, or with the fixed spots betokening that some limited portion of the retina has become insensible to light. A careful attention to the appearances of the *muscæ volitantes*, as I have described them, will enable the patient to convince himself of their real nature; and the Surgeon may console him with the assurance that, although incurable, they are perfectly compatible with excellent and enduring sight.

It is to be hoped that medical men in general will speedily arrive at this conviction; for it is lamentable to meet with patients who have gone through years of treatment, often of the severest kind,—even to bleeding and salivation,—or at best through an equally ineffectual course of tonics and local applications, and after all have remained with their muscæ undiminished, and their minds still burdened with anxiety and fears of approaching blindness.*

Appearances so common as floating muscæ will of course be observed by multitudes of persons who subsequently may become the subjects of either amaurosis or cataract. All I mean to insist upon is, that the muscæ and the diseases of retina or lens have no causal relation to each other.

Choroiditis. I have endeavoured to point out the real nature of two very common affections, frequently described as arising from "congestion of the choroid," but which really depend on a totally different cause. "Is there, then," it may be asked, "no such disease as *choroiditis*, which occupies so prominent a place in most of the ophthalmic text-books?" Of course a structure like the choroid, almost wholly composed of a mass of blood-vessels, cannot fail to play an important part in all hyperæmic conditions of the eyeball. But that choroiditis, as a separate and independent disease, can be distinguished by such well-defined symptoms as are described in ophthalmic works, is disproved by the revelations of the ophthalmoscope. Patients are daily to be met with who have long suffered from defective sight, in degrees varying from a state in which it is difficult to read or to distinguish minute objects, up to that condition of dimness in which merely the form of large objects can be faintly discerned: to ordinary observation the eyes may appear quite sound, the pupils being active, and every tissue presenting the aspect of perfect health; and yet the ophthalmoscope may at once reveal morbid changes, which could only have been produced by extensive and long-continued disease of the choroid, portions of this structure having undergone atrophy to such an extent as wholly to have disappeared, leaving the sclerotic exposed to view; masses of pigmentous deposit overspreading the greater part of the choroidal surface, or effusion of serum having occurred in such quantity as to have detached a considerable portion of the retina from its position.

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* Some interesting experiments made on himself by Mackenzie, to determine the seat of *muscæ volitantes*, were first published in the *Edinburgh Med. and Surg. Journal* for 1845, and again in his *Practical Treatise*, &c., 1854, p. 951. See also Jago, *Ocular Spectres and Structures as mutual Exponents*, 1856.

While, therefore, the most extensive changes may go on in the choroid without any external signs of disease, and without the patient being sensible of any thing more than a slowly advancing dimness of sight, other cases of a totally different kind occur, in which the choroid becomes inflamed in common with nearly every tissue of the eyeball. The first symptoms noticed by the patient are referable to the retina, such as mistiness of vision, irregular refraction of luminous rays, subjective sensations of light and colours. Next, the pupil becomes sluggish, and at last wholly inactive, its area being either dilated and slightly irregular, or else contracted and angular from adhesions having formed between the pupillary margin and the capsule of the lens. Meantime the iris gradually approaches the cornea, a vascular zone is developed in the sclerotic, and the veins of that part and of the conjunctiva become distended and tortuous.

Should the lens eventually become opaque, the cornea misty, and the globe hard, the phenomena constituting "glaucoma" would be complete. Otherwise, the diseased condition of the eyeball would correspond to that variously described by authors under the names of "chronic choroiditis," "sclerotico-choroiditis," "choroido-iritis," &c.

While the ophthalmoscope has enabled us to examine with the utmost precision various products of choroidal inflammation, such as extravasations of blood, effusions of serum, deposits of pigment, &c., the first commencement of the inflammation itself eludes our research. The size of the choroidal vessels, and their degree of distension, vary so much in different persons, that it is difficult, if not wholly impossible, to pronounce with certainty whether congestion does or does not exist in a given case. The quantity of hexagonal pigment-cells between the choroid and the retina also varies greatly in different subjects; and the amount of this pigment, and the degree of thickness in the retinal tissue itself, will materially influence the appearance of the choroidal vessels, imparting to them in one case great prominence and distinctness, and in another case, although the vessels themselves may really be in the same condition, subduing their brightness of colour and distinctness of outline.

The more practice a Surgeon has had with the ophthalmoscope, the less will he be inclined to pronounce positively as to the existence of "congestion of the choroid" in any given instance; and he will still have to base his diagnosis upon a careful inquiry into the patient's general health, and the symptoms which characterise the failure of vision.

If a patient is gradually losing his former distinctness and clearness of sight, both for near and distant objects,—fixed clouds and spots permanently or occasionally appearing in his field of vision, and luminous flashes or sparks being seen in the dark,—we are not at once to assume that the choroid is congested, and to put in practice the depletory measures advocated in our older text-books. All these symptoms may depend upon quite an opposite condition, and an insufficient supply of blood to the choroid and retina may be the real cause of the phenomena. If the symptoms just mentioned be only occasional, and the patient enjoys intervals of good sight, we shall probably find something abnormal, either in the circulation or digestion, to account for them; nor should we specially direct our treatment to the eyes until we have, as far as possible, corrected whatever we find amiss in the patient's general health.

The presence of a permanent spot or cloud in the field of vision, or a portion of it being altogether a blank as regards the form of objects, would at once induce us, before proceeding further, to dilate the pupil and use the ophthalmoscope.

Retinitis. As with the choroid, so it has fared with the retina, in respect of its supposed diseases and their symptoms. In the older ophthalmic works precise and distinctive descriptions are given of the symptoms of retinitis, which we now know to be altogether fanciful and imaginary. One of the most extensive forms of retinal inflammation, that originating in syphilis, is proved by the ophthalmoscope to be a not unfrequent associate of the disease which still retains the restricted name of "iritis;" and yet, while this syphilitic inflammation of the retina is going on, there are none of the symptoms of retinitis, as formerly described by ophthalmic writers.

In patients who have long experienced impairment of vision, terminating in total loss of perception of light, the ophthalmoscope not unfrequently exposes to our view an amount of deposit on the retina, both opaque and pigmentous, such as could only have resulted from active inflammation; and yet, the progressive failure of sight has been painless, and quite unattended by any symptoms analogous to those formerly received as indicating retinitis.

If it be said that these are instances of *chronic* inflammation, and that the *acute* form must certainly be attended with all the phenomena of hyperæsthesia of the retina, the ophthalmoscope again contradicts the old opinions. Cases occur in which a sudden cloud appears to come before one eye, shrouding all objects in a dense mist, or wholly destroying the perceptive power of a large portion of the retina. No pain whatever occurs in the eye, nor is the patient sensible of any luminous appearances; while the iris and all superficial parts remain perfectly unchanged. Let the pupil be dilated, and the ophthalmoscope applied, and the greater part of the retina will be seen overspread with blood, poured out from some ruptured retinal vessel; and yet the hyperæmia, which must have preceded such rupture, may have been unattended with any subjective sensations of light.

It is well observed by Mackenzie,* that "the accounts given by authors of the symptoms of inflammation of the retina are remarkably discordant. This arises in some instances from diseases altogether different from one another, except in so far as they speedily end in loss of vision, being designated by the name of *retinitis.*"

No better proof can be given of the truth of Mackenzie's remark than is afforded by comparing the symptoms of retinitis as described by him and by Tyrrell. The reader would not suppose that the two authors were speaking of the same disease.

Tyrrell's† description of "acute retinitis" by no means presents to us the symptoms of a disease confined to, or even originating in, the retina; and indeed, at another part of his work, he uses the term "acute retinitis" as synonymous with "glaucoma."

In fact, the terms *retinitis* and *choroiditis* originated in a desire to apply a precise and anatomical nomenclature to morbid conditions altogether obscure. Before the invention of the ophthalmoscope, this nomenclature passed unchallenged; for neither the active disease, nor the morbid changes resulting from it, could be investigated in such a manner as positively to prove or disprove the Surgeon's diagnosis; and he pronounced a case to be choroiditis or retinitis, according to the preconceived notion he might have formed as to the effects which such inflammations would produce on vision.

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* *Practical Treatise,* &c. 4th edition, p. 573.

† *Practical Work,* &c. vol. ii. p. 146.

Amaurosis.

The reader of any work professing to describe the diseases of the eye is sure to turn to the section "Amaurosis," in search of information on the difficult and obscure forms of defective vision which have long been classed under that head.

But the ophthalmoscope has so completely revolutionised all previous theories respecting diseases of the retina and optic nerve, that we can no longer content ourselves with a vague term which tells us nothing whatever as to the physical cause of the patient's malady, but simply implies that his *sight is dim.* The humorous definition attributed to Walther was in his day strictly true, when applied to cases of *total* blindness from disease of the nervous tissues; "Amaurosis," he said, "is a disease in which the patient sees nothing,—and the physician nothing."

Before the invention of the ophthalmoscope, the hinder surface of the lens might be said to form the boundary between a portion of the eyeball accessible to observation, and an unknown region in which the most important changes might go on without the possibility of their being investigated. Many of the nervous diseases of the eye must ever remain obscure and undemonstrable, originating, as they do, in the optic nerve and brain; and even those changes in the retina and choroid which are rendered visible by the ophthalmoscope are in many instances only the result of morbid processes which we cannot explain, or are unable to control.

Still the value of the information we gain by the ophthalmoscope even in these cases is immense; for it proves the utterly incurable condition of patients who, only a few years ago, would have been subjected to salivation, and other treatment ruinous to health, in obedience to some theory of disease which the Surgeon framed to himself, to account for the assumed condition of the retina. If a patient had become blind without visible inflammation of any kind, his pupils being dilated and fixed, and no opacity being visible in the lens, "mercury," it was said, "would give him a chance."

The failure of sight may have been ushered in with subjective luminous appearances, sparks, flashes of phosphorescent clouds; or dark spots, varying in size, form, and density, may be seen when the eyes are directed towards light-coloured surfaces.

In other instances, the patient will be sensible only of a general mistiness enveloping all objects. The power of reading may be limited to large and clear type, or perhaps even small type may be legible, but as if seen through a fog.

There may be every intermediate stage between defective sight of this kind, and a condition in which the outline of large objects only can be recognised, or even perception of light is wholly lost.

The defect may exist in both eyes to the same extent, or in unequal proportions; or one eye may be wholly blind, while the sight of the other is perfect. A similar difference may exist in the degree of mobility and dilatation of the pupils. There may also be the additional complication of defective motory power in the muscles of the eyeballs or lids.

When a patient, affected with the above-mentioned symptoms, presents himself for our opinion, we must be on our guard against allowing ourselves to prejudge the case by indulging in any theoretical speculations about "amaurosis." The word, or the vague notions which the word suggests, can only mislead us. Our first business is to make a careful examination of the eyes, and, until that is concluded, to discard all theory.

Each eye must be examined separately. If the patient retains the power of reading, we must carefully note what sized type each eye is capable of discerning, and whether convex or concave glasses assist the sight. An uneducated person, who cannot read, may be told to count small dots, point out an asterisk, a double line, or some other typographical mark. The power of more distant vision will be tested by objects about the room or out of doors.

The condition of the pupils must next be examined. It is a common error to suppose that dimness of sight, depending on disease of the nervous apparatus,—"amaurosis," as it has been termed,—is invariably marked by a permanently dilated state of the pupils. This is by no means the case. An eye may be blind, insensible even to light, and yet the pupil may have retained its power of motion; and, on the other hand, dilatation of the pupil may exist in a high degree from simple paralysis of the iris, the function of the retina being quite unimpaired.

Dilatation of the pupil ensues whenever the whole of the third nerve has lost its motory power; but it sometimes happens that the loss of motory power is limited to the iris itself, constituting the affection termed *Mydriasis*. An eye with this defect is in the same condition as if it had been treated with a solution of atropine. Distant objects are discerned, although not so well as before, but near and small objects, types for instance, appear utterly confused; but if the patient looks through a small hole, such as a pin-hole in a card, he finds his power of reading at once restored.

No doubt a dilated condition of the pupils is a very frequent sign of lost or impaired vision from cerebral causes. The symptom is familiar to all who have seen cases of hydrocephalus, or other forms of disease producing pressure on the brain. All I mean to insist upon is, that the dilatation is not an invariable accompaniment of impaired or lost sight, originating in disease of the retina.

I have said that each eye must be separately examined; for it often happens, when one eye sees well and the other is insensible to light, that the pupil of the blind eye will contract whenever light is admitted to the sound one, but will remain perfectly immovable while the sound eye is kept closed. Each eye, therefore, should in turn be covered, while the Surgeon places his hand between the other eye and the window for a few seconds, and then quickly re-admits the light to the pupil.

If any slight irregularity of the pupil exists, its margin must be most carefully examined, to see if any adhesion (*synechia posterior*) exists between it and the capsule of the lens. Such adhesions often afford a valuable hint towards a diagnosis, as they prove that iritis must, at some period, have attacked the eye.

In cases where the Surgeon is in doubt whether *synechia* is present or not, the application of atropine will usually determine the question.

No careful Surgeon can have advanced in his examination of a doubtful case of defective sight as far as the point we are now considering, without detecting any considerable opacity that may exist in the cornea. But he ought to be aware of the serious obstacle to sight which a very faint central cloudiness of the cornea will produce, if it has resulted from old keratitis (see p. 709). I have seen many instances in which such faint diffused haze of the cornea had been overlooked, and the case pronounced to be "amaurosis."

That very faint haziness of the lens, which sometimes constitutes congenital cataract, is also occasionally overlooked; and I have seen several cases in which patients affected with this slight opacity of the lens—their pupils at the same time being large and sluggish—were for many years deprived of the opportunity of being cured by operation, in consequence of their being supposed to be the subjects of retinal or cerebral disease.

The application of atropine will enable us completely to explore the lens, and determine the question of its transparency. This subject will be again referred to under the head of "Cataract."

I will suppose the history of the case to have been ascertained; the present condition of the patient's sight to have been accurately tested; the pupillary margin found to be free from adhesions, and the cornea and lens absolutely transparent. To complete our diagnosis, the optic nerve, retina, and choroid must be explored by means of the ophthalmoscope.

Before proceeding to sketch the morbid changes which are seen in the deeper tissues of the eye, I must here make a digression, and briefly explain the mode of using the instrument, and describe the appearances of the retina and choroid in a healthy, or nearly healthy, state.

The Ophthalmoscope.

It is little more than fifteen years since Cumming* first demonstrated that, by a certain arrangement of light, the fundus of the healthy human eye could be made visible, so far at least as to allow of its colour being seen. Although he never obtained a view of the optic nerve or vessels of the retina, his investigations prepared the way for the discovery of the ophthalmoscope, by proving that the fundus of the living eye was not really a dark-coloured surface; but that under certain conditions it reflected the rays of light falling upon it, so as to present a brilliant surface to the eye of the observer. An indistinct reddish gleam from the retina, or a white reflection from the optic nerve, had been sometimes accidentally seen by those engaged in the study of eye-diseases; but they had regarded these glimpses of the fundus of the eye as exceptional, and as indicating something morbid in the deep tissues. Thus, in certain cases of impaired sight, with dilatation of the pupil, Beer had observed a peculiar luminous appearance, which he assumed to be the result of some morbid change in the retina; and he accordingly made use of the term "cat's-eye amaurosis" to designate the disease which he supposed to give rise to this luminous appearance. Other observers had attributed it to a deficiency of pigment in the fundus of the eye, still assuming that, in a state of health, the fundus must necessarily appear black.

The first ophthalmoscope was invented by Helmholtz, and described by him in a tract published in 1851.† He first merely demonstrated in how simple a manner, by using a slip of glass, the surface of the retina might be made visible; and then described a polarising apparatus for obtaining a more perfect view of the part. These first examinations were made without any artificial dilatation of the pupil, so that only a limited extent of the retina could be seen. He was able, however, to distinguish the optic nerve, and the vessels emerging from it.

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* *Medico-Chirurgical Transactions*, 1846.

† *Beschreibung eines Augenspiegels zur Untersuchung der Netzhaut im lebenden Auge*, Berlin.

In 1852 Ruete[*] invented an ophthalmoscope on a different principle from that of Helmholtz, light being thrown into the patient's eye by means of a concave mirror, through a hole in the centre of which the observer looked directly upon the illuminated retina. The practical objection to Ruete's instrument consisted in its being fixed to a stand, and therefore ill adapted to observe an organ so constantly in motion as the eye. Coccius[†] avoided this inconvenience by constructing a small perforated mirror, to be held in the hand; and this instrument was still further modified by Anagnostakis,[‡] whose ophthalmoscope, from its extreme simplicity, appears to me the most useful that has yet been invented.[§] It consists of a circular mirror, about an inch and three-quarters in diameter, slightly concave, and perforated in the centre with a round hole, the tenth of an inch wide.[‖] The mirror is set in a metal frame, to which a handle is fixed.

Before commencing the examination of a case, it is necessary to dilate the pupil with atropine, unless it has become permanently dilated from disease.

The observer and the patient sit face to face in a room from which daylight has been excluded; the only source of illumination being a lamp, or, still better, a jet of gas issuing from a jointed tube, so that the flame can be placed higher or lower, according to the height of the patient's head.

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[*] *Der Augenspiegel und das Optometer*, Göttingen.

[†] *Ueber die Anwendung des Augenspiegels*, Leipzig, 1853.

[‡] *Essai sur l'Exploration de la Rétine et des Milieux de l'Œil sur le Vivant*, Paris, 1854.

[§] The reader will find a comprehensive account of the various forms of ophthalmoscope in a recent work by Zander, *Der Augenspiegel*, Leipzig, 1859. The author classifies the instruments under three heads: 1. those having reflectors of plane glass, by Helmholtz and Follin; 2. *Homocentric* instruments, by Ruete, Anagnostakis, Ulrich, Stellwag, Hasner, Desmarres, Heyfelder, Liebreich, and Jæger; 3. *Heterocentric* instruments, with various combinations of lenses and prisms, by Coccius, Donders, Seemann, Meyerstein, Zehender, Klaunig, Burow, Hasner, &c.

[‖] The amalgam of the mirror is protected by a brass plate perforated at a spot corresponding to the hole in the glass. The inside of this perforation should be brushed over with a non-reflecting black coating, so as to prevent the metallic edge from producing small rays of light, which are very confusing to the observer.

The flame should be on a level with his eye, and just far enough behind him to prevent any of the direct rays falling on his cornea. The chimney surrounding the flame must be of transparent glass, and, if faintly tinged with blue, it will modify the red rays of the flame, and impart a whiteness to it, nearly resembling that of ordinary daylight. The observer places the back of the mirror close to his own eye, so that he looks through the central aperture, and holds the instrument at such an angle that the reflected light from it falls upon the patient's pupil. This is always very difficult for a beginner to accomplish; but a little practice soon makes it easy. The observer will know that he holds the instrument in the right position, and at a proper distance from the eye, by seeing the retina assume a brilliant reddish appearance.

Still holding the ophthalmoscope in the same position, he takes in the other hand a convex glass, of two inches or two inches and a half focus, and places it at such a distance in front of the cornea as to allow of the retina coming within that focus. If the fundus of the eye be properly illuminated, and the convex glass correctly placed, some of the retinal vessels will now be distinctly seen.

To bring the optic nerve into view, the patient must direct the eye a little towards the nose; and by turning the eye in various directions every portion of the retina is successively brought under the view of the observer. The necessity for varying the position of the eye constitutes a great objection to the more complicated ophthalmoscopes, which are fixed to a table or other support; and some eyes are so unsteady, and so little under the patient's control, that the observer is obliged to follow their movements by slight changes in the position of the ophthalmoscope, which can only be effected when the instrument is held in the hand.

Some ophthalmoscopes present an upright, some a reversed image of the optic nerve and retina. The simple mirror of Anagnostakis, used in combination with a convex glass, in the manner I have described, certainly allows of our seeing in their real position parts which do *not* fall within the focus of the patient's crystalline lens. Thus a morbid growth—an encephaloid mass, for instance—which might be seen on the floor of the vitreous chamber, would be found really to occupy that position when the globe had been extirpated. But the optic nerve and retina, lying within the focus of the patient's lens, are seen reversed; so that the axis of vision, which is really placed on the temporal side, appears to lie on the nasal side of the nerve, and an extravasation of blood, or patch of pigment, below the nerve would appear to be above it.

Ophthalmoscopic Appearances of the Eye in a healthy state.

In the heading of this section I use the word "healthy" with a certain latitude of meaning; for, apart from any serious disease, the mere advance of age imprints upon the internal tissues of the eye certain changes of appearance, which, although deviating from an ideal standard of perfect health, can hardly be termed morbid. At present, I wish to present to the reader merely a sketch of what he is to look for in an eye which fairly performs its functions as an organ of vision.

Retina. The observer must not expect to find this tissue presenting one uniform colour in all cases; the tint varies from pale red, through shades of red-orange and yellow-orange, to buff. In full-blooded persons, with a vigorous circulation, the retina would naturally have a much redder appearance than in those who are feeble and anæmic. The colour of the retina is due, partly to its own capillary network, the individual vessels of which are of course too small to be recognised as such, and partly to the vascular choroid behind it. The amount of redness transmitted from the choroid will depend upon the quantity and condition of the hexagonal pigment between it and the retina.

Across the illuminated fundus of the eye the observer will notice large vessels radiating from a central point towards the periphery. These are the large branches of the central artery and vein of the retina; and by directing the patient to turn the eye a little towards the median plane, the observer will be able to trace these vessels to their parent trunks in the middle of the optic nerve. The vessels of the choroid, as I shall by and by have occasion to notice, are so entirely unlike the radiating trunks of the retina, that a single examination will suffice to prevent any subsequent confusion between them.

It requires a little more practice to distinguish between the retinal arteries and the veins. If an arterial trunk be examined where it attains its greatest size, namely, at its emergence from the optic nerve, it will be observed to be of a paler red colour than the adjacent vein, and to present a double outline. The greater thickness of the arterial wall is the cause of both these peculiarities of appearance; for, of course, the colour of the contained blood is less plainly seen where the wall is thicker; and while the light, reflected from behind the artery, shines through it with subdued brightness, each side of the cylinder presents a line of shadow. The coats of the veins, on the other hand, are so thin, that they allow the colour of the blood to be plainly seen throughout the whole diameter of the tube. This distinction between the veins and the arteries of the retina becomes less marked as age advances. Simple inspection of a healthy eye does not detect any pulsation in the retinal vessels; but if the globe is firmly pressed with the finger, a decided pulsation may be seen, both in the arteries and veins.

Optic nerve. No structure seen with the ophthalmoscope presents a greater variety of appearance than the optic nerve, even in patients who enjoy good sight. As age advances it becomes smaller, and often deviates more or less from that circular outline which one may assume as the healthy standard.*

Contrasted with the reddish tint of the surrounding retina, the nerve appears cream-coloured, or it sometimes presents that faint tinge of pinkish-gray which we are familiar with in the cineritious portion of the cerebral convolutions. The extreme edge of the disk is of a more decided white than the central portion.

From the centre of the nerve the main trunks of the retinal artery and vein are seen emerging. Commonly each vessel issues as a single trunk, which then divides into branches, but sometimes the division into two or three trunks takes place before the vessels quit the substance of the nerve in which they are imbedded.

The remark I made as to the varying degrees of redness exhibited by the healthy retina in different persons, applies also to the variety in size and form which the main trunks assume on the surface of the nerve. In some cases the vessels pass off at once to their destination, in nearly straight, or slightly wavy lines, while in other cases they form several abrupt curves on the surface of the nerve before quitting it.

Choroid. This structure exhibits a great variety of appearances under the ophthalmoscope. The distinctness with which it is seen depends upon the degree of transparency of the retina, and the condition of the hexagonal pigment-cells behind it; and it seems that considerable variations in both these tissues are compatible with good sight.

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* I have uniformly spoken of the *optic nerve*, instead of using the term "optic papilla," which some authors employ. No confusion can arise from applying the term *nerve* to that which is in reality only a part of the nerve, since no other portion than its extremity comes under our notice in using the ophthalmoscope. The term "papilla" is objectionable too, as implying a *prominence*; and I believe the distal end of the optic nerve to be nearly, if not quite, plane in a state of health.

In young persons the vessels of the choroid appear dim and indistinct, as if overspread with a thin semi-opaque film; but in old persons they are sometimes so plainly seen that the observer almost forgets he is looking at them through the whole substance of the retina. It is in old persons, therefore, that the peculiar arrangement of the choroidal vessels can be best studied. They are very much larger than the radiating vessels of the retina, and are closely packed together, leaving between them narrow linear spaces, in which dark pigment is visible. During the earlier periods of life these vessels present a bright red, but in old age this colour becomes mixed with a brownish tint.

Morbid Appearances of the Retina, Optic Nerve, and Choroid.

Any verbal description of the various changes in the deep tissues of the eye, which the ophthalmoscope exhibits to our view, must of necessity be very imperfect; such a description may, indeed, recal to memory peculiarities of form and colour which have already been studied in the living subject; but to the beginner it can suggest only a faint and shadowy picture. In many instances, too, we must content ourselves with describing appearances, the real nature of which we are at present unable to explain.

Retina and optic nerve. In patients affected with general dimness of sight, in that slight degree which has been vaguely termed "amblyopia," it is not uncommon to find a dusky *halo* surrounding the optic nerve. It resembles a very faint wash of Indian ink, and is gradually shaded off, and altogether lost, at some distance from the nerve, the peripheral portion of the retina presenting a natural appearance. I can offer no explanation as to the cause of this halo, nor would I lay much stress upon it as a sign of structural change, inasmuch as it is sometimes met with in patients whose failure of sight is only occasional, and clearly traceable to derangement of the general health.

In old persons, whose dimness of sight would suggest the existence of commencing cataract, we occasionally find a *white patch* of variable extent, and very irregular outline, immediately surrounding the optic nerve. Sometimes this patch is of such extent as to encroach upon that portion of the retina corresponding to the axis of vision. These patches are of an opaque dead white, and are quite devoid of vessels. They seem to be due to chronic hardening and condensation of the nervous tissue, with obliteration of the vessels of the part. In some instances, perhaps, fatty degeneration may also be present.

In several cases of Bright's disease, accompanied with great dimness of sight, yellowish-white spots have been seen scattered over the surface of the retina. I am acquainted with only one case in which the fatty nature of these deposits has been proved by dissection.*

The changes in the retina and optic nerve consequent upon syphilitic inflammation have been already noticed in the section on iritis (p. 745).

A very remarkable appearance connected with the optic nerve consists in a white patch, of a crescentic form, so immediately in contact with the margin of the nerve as to seem at first sight to form part of the nervous tissue itself. This crescentic patch has been recently described by German writers under the name of "staphyloma scleroticæ posticum," from a supposition that there was at this spot an actual protrusion of the sclerotic.† I am not aware of the existence of such a staphyloma having been proved by actual dissection.

In an eye which presented the crescentic patch in a very marked degree, it was found that the pigment-cells of the choroid were altogether wanting throughout the whole extent of the crescent, so that the light from the ophthalmoscope passed through the transparent retina and choroid, and was reflected from the sclerotic itself, which at this point was thinner than natural, but not at all prominent or staphylomatous.*

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* The case is reported by Heymann, in the *Archiv für Ophthalmologie*, vol. ii. p. 139, 1856. During the progress of the disease the patient became maniacal, so that the ophthalmoscopical examination was difficult. The loss of sight was almost total in both eyes. The media were clear, and an irregular yellowish-white patch was observed just below the optic nerve (it is not stated in which eye). Both eyes were examined after death, and presented nearly similar appearances. At a distance of a line or two from the optic nerve, about twenty yellowish-white spots, of various sizes, were arranged in an irregularly circular figure. The largest spot which had been seen during life was situated below the optic nerve, and about a millimetre in diameter. A microscopical examination of the spots, which were all of a yellowish-white colour, proved them to be isolated portions of fatty degeneration in the ganglionic structure of the retina.

† E. Jæger, *Beiträge zur Pathologie des Auges*, 1858, plate xvii. A representation is here given of a well-marked crescent, fringed with pigmentous deposit, which was observed in a very short-sighted patient. Plate xviii. shows a still larger crescent, in a case of more advanced myopia. This figure also exhibits the choroidal vessels with that extreme distinctness which is caused by absence of the hexagonal pigment.

Among the more striking appearances under the ophthalmoscope are the irregular deposits of black pigment on the illuminated field of the retina. These pigmentous deposits present endless varieties as to quantity and mode of arrangement. In one case two or three minute isolated dots may alone be visible; in another case the pigment may assume the form of fine threads, ramifying over a considerable portion of the retinal surface; while, in a third case, the pigment may be aggregated in large black masses, the intervening portions of retina being of healthy appearance.

Pigmentous deposits are met with at all ages, and generally appear to be a sequel of chronic inflammation, although it very often happens that the patient can give no account of such an attack. Pigment is also commonly seen interspersed in large quantities among the white patches resulting from syphilitic disease of the retina.

When a vessel, in either the choroid or the deeper portion of the retina, has given way, and broken up the tissues immediately surrounding the extravasation, absorption of these tissues, as well as of the blood, may subsequently take place to such an extent as to lay bare the sclerotic. A rounded white patch is thus produced, which is usually fringed with a black edge of pigment. In other cases the whole site of the extravasation becomes covered with pigment, so that, instead of a black ring, an irregular black disk is the result. I have met with several instances in which a fringed or blackened patch of this kind was situated directly in the axis of vision. Sight was very imperfect, and limited to a very small space; so that, in the attempt to read a large type, only a single word, or part of a word, could be taken in at a glance.

Extravasations of blood, either from the retina or the choroid, constitute, I need hardly say, the most serious accidents to which those tissues are liable. The blood may be effused in consequence of a blow on the eyeball, or it may escape spontaneously from a distended vessel giving way, as in ordinary apoplexy.

It is remarkable that rupture of a retinal vessel sometimes occurs without any of the symptoms which one might expect would accompany it,—such as giddiness and other signs of cerebral disturbance. I have seen many cases in which a dimness or cloudiness has suddenly overspread one eye, while the patient, in apparently good health, was quietly engaged in reading or writing; no pain or uneasiness of any kind accompanying the attack, the iris retaining its mobility, and even the conjunctiva and sclerotic showing no trace of increased vascularity. The patient finds that a considerable portion of his field of vision has become a total blank as regards perception of objects; while, perhaps, he still retains the power of dimly discerning those which happen to fall on some limited portion of the retina. If such a case is examined within a few hours, or even a few days after the rupture of the vessel, the fresh red colour of the effused blood will at once be recognised. If it is one of the radiating vessels of the retina that has given way, the prognosis will be much more favourable than if the hæmorrhage had come from the choroid; for, in the former case, the tissue of the retina, although for a time overspread with blood, and so rendered incapable of receiving visual impressions, may have escaped any serious disintegration; whereas, if the blood has proceeded from the choroid, it may have actually ruptured the retina, and irreparably destroyed that portion of it as far as its function is concerned. The presence of clots freely floating in the vitreous humour would be a still more unfavourable sign, as it would prove that the tissue of the vitreous body had, to a certain extent, been broken up. This latter complication more frequently results from blows on the eyeball than from spontaneous apoplectic extravasation.

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* See a plate in the first vol. of the *Ophthalmic Hospital Reports*, figs. 4 and 5. The nerve in both these figures is over-coloured, so as to present too marked a contrast to the whiteness of the crescent. The dissection by Dr. Bader, alluded to above, will be found at p. 117 of the volume just quoted.

No one who has had a little practice with the ophthalmoscope can find any difficulty in detecting a recent extravasation of blood on the surface of the retina; but the recognition of the changes which mark the site of old extravasations is often extremely difficult. I have already noticed the cases in which a rupture of choroidal vessels breaks up and destroys a limited portion both of the choroid and retina, leaving either a well-defined space of white sclerotic, or a patch of dark pigment, to mark the site of the disruption. But a less extensive extravasation, originating in the rupture of a superficial vessel of the retina, may leave such faint traces as almost to escape observation. Sometimes the site of the rupture is marked by a slight brownish stain, in other cases by a faint mottling of the retinal surface; while a more extensive extravasation may so far damage the retina as to leave in after-years a linear or stellated cicatrix (if one may so term it), of a lighter colour than the surrounding tissue.

Serous effusion between retina and choroid. This effusion may occur as a result either of acute or chronic inflammation. As a result of *acute* disease, it forms one of that group of morbid changes which, taken together, constitute "glaucoma," and will hereafter be spoken of under that head.

Chronic effusion between the retina and choroid may take place in the most gradual and insidious manner, so as only to manifest itself by impairment of vision, unattended with any pain or external signs of inflammation.

When the retina has become detached to a very considerable extent, a corresponding portion of the field of vision becomes a total blank so far as perception of objects is concerned; while that portion of the retina which remains in apposition with the choroid may still distinguish even small objects, although in an imperfect and partial manner.

There are no external signs by which we can ascertain the existence of effusion beneath the retina. The ophthalmoscope alone enables us to detect it.

The effused fluid may either exist in such a small quantity as barely suffices to impart a cloudy appearance to a limited portion of the retina; or it may have detached a considerable extent of the retina, or even the whole of it, from its connexion with the choroid.

The more limited effusions frequently occur in the immediate neighbourhood of the optic nerve. At first sight they appear as grayish or cloudy patches in the midst of healthy tissue, and the radiating vessels which are spread out over the rest of the fundus of the eye appear to be lost when they arrive at the edge of the patch. This appearance is owing to the fact of the vessels being raised up by the effusion beneath them, so that they are on a plane different from that of the vessels of the healthy retina. A slight movement of the convex glass, which the ophthalmoscopic observer is employing, will at once bring into focus the vessels overlying the effusion.

When a large portion of the retina has been separated, it presents the appearance of a lobular mass, of an opaque grayish colour, contrasting in a remarkable manner with the reddish reflecting surface of that part of the retina which still retains its natural position. Sometimes the lobular mass may be observed to oscillate with each movement of the eye; and when brought into focus the surface of the mass is seen to be overspread with ramifying vessels, the displaced veins of the retina.

When almost the entire retina is detached from the choroid, the appearances under the ophthalmoscope are at first very difficult to understand. The whole fundus of the eye appears at one moment of a dull gray, as if covered with a milky gelatinous deposit; then the white disk of the optic nerve comes for an instant into view, and then again a sudden turn of the eyeball affords a glimpse of some very limited portion of undisplaced retina, which still dimly reflects the luminous rays which fall upon it. Not unfrequently the view of the fundus is still further confused by floating bodies dispersed through the vitreous humour.

The optic nerve. I have already described the appearance of this nerve in health, and have incidentally noticed a few of its morbid changes, such as are found in connexion with myopia, and with syphilitic inflammation of the iris.

Very great variations in the form and colour of the nerve are compatible with good sight. As age advances, the tissue of the nerve appears to becomes denser, less succulent, so as to occupy a smaller space than in early life. Its colour also becomes darker, and in some old persons approaches to gray, while its outline slightly deviates from that circular form which one must assume as the standard of perfect health. Indeed, it is extraordinary to see how much variety in its size, form, and colour may coexist with a fair amount of vision.

A very common appearance is that of a thin line of black pigment skirting the margin of the optic nerve to the extent of a sixth or a quarter of its circumference. One must regard this pigmentous deposit as morbid; but its existence cannot be of very great importance, inasmuch as we so frequently meet with it in eyes which, if judged by their power of vision, might be almost termed healthy.

One of the most remarkable changes to which the optic nerve is liable, is that observed in cases of blindness from cerebral disease, involving that portion of the optic nerve which is contained within the cavity of the skull. In old-standing cases of this kind we find evidences of chronic congestion of the retina, and degeneration of the optic nerve. The retina presents a uniform red colour, sometimes so strongly marked that no trace of choroidal vessels can be seen, and the vessels radiating from the centre of the optic nerve are almost lost in the deeply tinted surface on which they lie.

Contrasting strongly with the red retina surrounding it, the optic nerve at once attracts attention by its extreme whiteness, which resembles that of ivory, rather than the creamy or faintly pinkish tint which I have described as characterising the nervous tissue in a state of health. It is probable that these dense-looking, homogeneous, white nerves have undergone atrophy, and have lost the greater portion of their true nervous element, little more than the fibrous tissue remaining.

The combined appearance of a red, thickened retina, and a homogeneous, white, optic nerve, at once assures the practised observer that the case is already beyond recovery.

Within the last three years much attention has been drawn to a pitting, or indentation of the extremity of the optic nerve, which is met with in certain cases of greatly impaired or lost vision; and inasmuch as this concave appearance of the nerve is sometimes seen in combination with those inflammatory changes in the eyeball which constitute *glaucoma*, it has been asserted that a concave state of the nerve is pathognomonic of that formidable disease. Over-distension of the eyeball, it was said, produced this indentation of the nerve; and "intraocular pressure," therefore, was announced as the primary cause of glaucoma, which had so long baffled the researches of ophthalmologists.

More extended observation, however, brought to notice numerous cases in which pitting of the optic nerve existed in an extreme degree, without inflammatory changes in any of the tissues of the globe;* and Gräfe, who had especially drawn attention to the pitting of the optic nerve as diagnostic of glaucoma, modified his views on the subject, and in the third volume of his *Archiv für Ophthalmologie*, p. 484, described a form of "amaurosis, with excavation or retraction of the optic nerve," as a condition quite different from glaucoma.

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* While engaged upon this section, I have had the opportunity of examining the most remarkable instance of concave optic nerve that has ever come under my observation. The patient was a healthy countryman, a shepherd and farm-labourer, forty-six years old. During three or four years he had complained of a gradual dimness of sight, commencing in the right eye, and gradually extending to the left. No pain, nor any appearance of colours or flashes, had ever been experienced. When I saw him, both eyeballs looked healthy; the irides were vertical, and the pupils, which were not dilated, retained their activity in almost a natural degree. With the right eye the man could barely perceive direct daylight; with the left he could discern the light reflected from a hand or a sheet of paper, but could not recognise the form of these objects. Having dilated the pupils with atropine, I used the ophthalmoscope. All the media were brilliantly clear, nor was there any thing very remarkable in the condition of the retinæ. Each optic nerve, however, was concave to such an extent as I never before witnessed; the white margin of the nerve standing out in relief, like the edge of a cup, over which the central artery and vein passed, with a very marked and abrupt curve.

If, however, a marked pitting or indentation of the optic nerve may exist without any of the inflammatory conditions of glaucoma being present, why are we to assume that when a similar state of the nerve accompanies glaucoma, "intraocular pressure" is the cause of the indentation? Is it not more probable that in all cases the indentation is due to atrophy, and consequent shrinking of the nerve-tubules?

Atrophy of the optic nerve and retina. Several of the morbid changes which I have already noticed as affecting these structures are attended with more or less wasting of their true nervous elements. Such is the case with the *white patches* on the retina of old persons, and the homogeneous white optic nerve accompanying intracranial disease of the optic apparatus; it is probable that the pitting or indentation of the nerve in glaucoma, and in other non-inflammatory cases of slowly advancing blindness, is, as I have just observed, also due to the same cause.

But there are cases of atrophy which seem to affect the whole retina and optic nerve, without any previous inflammatory process. This condition is chiefly met with in old persons, but it also may befal those in the middle period of life. The power of sight gradually fades away year by year, until eventually mere perception of light alone remains. The opthalmoscope reveals a perfectly clear condition of the media, and at the same time affords such a complete view of the choroidal vessels, that the observer could almost fancy the retina to be altogether absent. The optic nerve is small and shrunken, irregular in its outline, and of a dark gray or drab colour; and the vessels emerging from it form delicate, hair-like, red lines, barely traceable across the area of the illuminated choroid.

In some instances I have seen this extreme atrophy of the retina accompanied with a very remarkable change in the choroidal vessels, their colour being pale orange or buff, instead of red.* This appearance I have met with only in old people; and their failure of sight has been so slow, and unattended with marked symptoms of any kind, that they have been supposed to be the subjects of steadily advancing cataract.

Treatment of amaurosis. To the reader who has just gone through the foregoing details, descriptive of so many morbid changes in the deep tissues of the eye, such a heading as "treatment of

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* See E. Jäger, *Beiträge zur Pathologie des Auges*, Taf. vi.

amaurosis" must appear almost ironical. "How unreasonable," he will say, "to bring together under one head diseases of such various kinds, affecting parts as various in their structure! Extravasation of blood from the vessels of the retina, wasting of the optic nerve, effusion of fluid between the retina and choroid,—all these, and many other equally dissimilar conditions, convey to the patient, it seems, almost the same sensations of imperfect sight; and all before the invention of the ophthalmoscope were doubtless grouped together under one common name. But where, among all the morbid changes I have been reading about, am I to find *amaurosis?*"

Nowhere, I reply, unless we are content to retain the term to designate those forms of impaired sight which cannot be traced to any disease in the deep tissues of the eye, but depend upon changes in that portion of the optic apparatus contained within the cavity of the skull, regarding the brain, in short, as the *terra incognita* which the retina really was previous to the discovery of the ophthalmoscope.

If the reader now refers back to the sketch I have given of the morbid changes in the retina and choroid,—bearing in mind that, for the most part, they are unattended by any well-marked external signs of disease,—he will at once perceive how impossible it must be to lay down any rules for treatment that will be uniformly applicable to all so-called "amaurotic" cases. In a group of patients, complaining of almost the same defects of sight, one will be discovered to have a portion of the retina overspread with blood; in a second, the axis of vision will be covered with a patch of pigment; while in a third, the retina and choroid will be partially separated by serous effusion.

Are these three patients to be treated alike? Do they, in fact, possess any thing in common? And yet they would all have been formerly classed together as "amaurotic," and probably have undergone salivation accordingly.

If the ophthalmoscope had done nothing else than limit the wholesale administration of mercury in eye-diseases, it would have conferred an immense boon upon mankind.

Even when it has been ascertained that an extravasation of blood has taken place from the vessels of the retina or the choroid, the treatment will require great care and discrimination on the part of the Surgeon. In one case the extravasation will have been accompanied, or immediately preceded, by giddiness and other symptoms of disordered circulation in the brain, and may have been induced by alcoholic or other stimulus, or by great muscular efforts in a plethoric and vigorous subject. Rest and abstinence may be indicated as the first preparatives for treatment. In another case, rupture of a retinal vessel may have occurred in a feeble and delicate patient, during a period of perfect repose, and may have resulted from a diseased and softened condition of the coats of the vessel itself. I have seen extravasations take place in such subjects in consequence of sudden exposure to cold, especially when the body or mind had been previously much exhausted. Here, moderate stimulants would be beneficial, and the absorption of the effused blood would be hastened by medicines of a tonic character,—iron or quinine.

In all cases of extravasation of blood from the vessels of the retina, the Surgeon should take care not to make unnecessary examinations with the ophthalmoscope, as each occasion of exposure to its strong light increases the congestion of the part, and consequently the liability to farther extravasation. I have known several instances of this kind, in which a fresh escape of blood immediately followed the use of the ophthalmoscope. Having once clearly made his diagnosis, the Surgeon may be satisfied as to the progress of absorption by the steady improvement of the patient's sight, and may postpone any farther use of the ophthalmoscope until recovery has been well established.

Where serous effusion has taken place between the choroid and retina, in addition to other general treatment, iodine internally, combined with blistering in the neighbourhood of the eye, may be tried; although, if the effusion be of old standing, and to a large amount, little, if any, benefit can be hoped for.

It must be evident that structures, like the choroid and retina, which derive their supply of blood from such remote and deep-seated sources, cannot be treated by local depletion, even if depletion were desirable. The Surgeon must seek to restore the balance of the patient's circulation by general treatment, based on a careful and comprehensive survey of constitutional peculiarities and mode of life, and especially of the habits or pursuits which may be supposed to have given rise to the local changes. Inquiries must be instituted as to the existence of any of those causes which impair the sight by exhausting the patient's general nervous power. The abuse of alcohol, tobacco, or opium; venereal excesses; protracted suckling, and many other depressing agencies, will suggest themselves to the mind of the acute practitioner.

He will take care not to trust too implicitly to this or that article of the pharmacopœia, and will especially be on his guard against the depressing agency of mercury,—the drug which he will find lauded almost as a panacea for "amaurosis" in some of the medical works of the last generation.

Galvanism and strychnine he will frequently hear spoken of as possessing wonderful efficacy in arousing the dormant powers of the optic nerve. The action of strychnine appears so entirely limited to the motory fibres of the nervous system, that to expect it to influence a nerve of special sense is to confuse all our notions of physiology. Galvanism has been at various times a favourite remedy with the public, and its administration admits of a parade of scientific apparatus which specially imposes on the popular mind.

Those who believe,—or make their patients believe,—that they can render cataractous lenses transparent by means of galvanism, will doubtless long continue to vaunt its efficacy in cases of the most complete disorganisation of the retina.

CHAPTER VI.

DISEASES OF THE VITREOUS BODY.

Before the invention of the ophthalmoscope, little was known about the morbid conditions of the vitreous humour. It was frequently found to become diffluent (*synchysis*) after injuries to the eyeball, and during the progress of certain chronic inflammations; and it was assumed to play an important part in glaucoma. The ophthalmoscope presents to our view a great variety of morbid products in the humour, which it is difficult to observe with accuracy, on account of the rapidity with which many of the flakes, filaments, and corpuscles, float about with every movement of the eye.

When *hæmorrhage* occurs from the ciliary processes, or from the superficial vessels of the retina, a portion of the clot not unfrequently becomes entangled in the vitreous humour, and forms an irregular, filamentous, black-looking* body, floating to and fro across the illuminated field of the ophthalmoscope.

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* I may here notice that these floating bodies in the vitreous humour are not necessarily *black* because they look so under the ophthalmoscope;

In *syphilitic inflammation* of the deep tissues, the vitreous humour loses its perfect transparency, and becomes turbid; and in severe cases, flakes of lymph are seen freely moving about in it, like tangled blackish threads.

A very singular phenomenon connected with the vitreous humour is that termed *sparkling synchysis* ("synchysis étincelant"), produced by the disintegration of an altered crystalline lens. This body, after becoming opaque from ordinary cataractous change, sometimes undergoes extensive fatty degeneration, crystals of cholesterine being abundantly formed within its substance. If a lens in this condition is broken up with the needle, or becomes ruptured and thrown down to the bottom of the vitreous chamber by a blow, the crystals of cholesterine are set free, and at each movement of the eye, appear as innumerable brilliant points, like the finest gold-dust, sparkling in the dark area of the pupil. When the eye is kept at rest, these crystals gravitate to the bottom of the mingled aqueous and vitreous humours, some sinking down behind, and some in front of the iris.

Sparkling synchysis is very rare, and I have not had an opportunity of examining any cases with the ophthalmoscope.

Cysticerci. Perhaps the most striking phenomenon connected with the vitreous humour is the presence of entozoa, either freely floating within it, or protruding into it from the surface of the retina, to which they are attached. All the cases of this kind which have as yet been recorded are to be found in foreign journals, for hitherto no case seems to have been observed in this country.*

Of eighteen cases reported in the *Archiv für Ophthalmologie*, sixteen appear to have been under the care of Gräfe. In *eight* cases the cysticercus was either embedded in the very tissue of the retina, or firmly adherent to its surface; in *four* cases, the creature appeared to be behind the retina; while in *six* cases, it was quite detached, and floated freely in the vitreous humour. This latter circumstance induced Gräfe, in two instances, to attempt the removal of the creature; in the first case, making an incision in the sclerotic and passing in a forceps through the wound; in the second,

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any body, sufficiently opaque to intercept the rays of light passing from the illuminated retina to the eye of the observer, will appear black, although if examined out of the eye, it might be found light-coloured, or almost white.

* The cysticercus in the *anterior* chamber has, however, been twice met with by Mackenzie. See note on p. 726, ante.

adopting a slower and more complicated proceeding. First, a portion of the iris was excised, so as to make a large artificial pupil; then, when all irritation had subsided, the lens was extracted through the ordinary corneal section; and lastly, after a considerable interval of time had been allowed to elapse, a forceps was introduced through an opening made in the cornea, and the cysticercus grasped and drawn out.

Desmarres* has met with one case of cysticercus; and another is reported by Williams† as occurring in the United States.

My colleague, Mr. Hulke, in dissecting a disorganised and irritable eye, which had been removed by operation, found a cysticercus lying between the choroid and retina; and Professor Esmarch, of Kiel, informs me that he also found a cysticercus in the same situation.

From a review of all these cases, it appears to me almost certain that the cysticerci found loose in the vitreous humour had attained that position by perforating the retina, having been originally formed between that tissue and the choroid, in which situation I conclude that all the cysticerci above described were originally developed.

The very curious researches recently made into the natural history of intestinal parasites have proved that the *cysticercus telæ cellulosæ* and the tænia are really the same creature in different stages of development.‡

I believe it has been well ascertained that the natives of Northern Germany are more liable to tape-worm than those of the British Islands, and this circumstance would account for the fact of the cysticercus having been so much more frequently met with among the former.

CHAPTER VII.

DISEASES OF THE LENS AND ITS CAPSULE.

In a state of health, the lens and the membranous capsule enclosing it are perfectly transparent. In early life they are also quite colourless; but after the age of thirty the lens in most persons begins to assume a pale-yellow tinge; and this gradually becomes more marked as age advances, until in old subjects it frequently acquires the colour of amber.

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* *Traité théorique et pratique des Maladies des Yeux*, 2d ed. 1858, vol. iii. p. 756.

† *Cincinnati Lancet and Observer*, May 1858.

‡ See Küchenmeister and Von Siebold *on Animal and Vegetable Parasites.* (Sydenham Society, 1857.)

Any loss of transparency in the lens, whether affecting the whole or only a portion of it, constitutes *cataract;* and in strictness this term should be limited to changes in the lens and its capsule.

To call an opaque inflammatory effusion in the area of the pupil a "spurious cataract," is to introduce a loose and uncertain terminology, which can only give rise to confusion in our descriptions of disease.

Abnormal position of the lens. The "suspensory ligament," which is attached to the capsule all round the margin of the lens, maintains it in position, and, in a healthy state, can only allow of very slight movements in an antero-posterior direction. By these movements we may suppose that the adjustment of the eye to distances is regulated, unless we accept the theory which attributes this adjustment to an actual change in the form of the lens.

A blow on the eye sometimes ruptures a portion of the suspensory ligament, and allows the lens to become tilted backwards. If the ligament is detached to a considerable extent, the lens sways to and fro with every movement of the globe, and vision is much confused. Eventually, under such conditions, the lens becomes opaque; but I have seen cases in which it remained transparent for a very considerable time.

It appears that the suspensory ligament is liable to a congenital defect, whereby the lens, instead of maintaining its normal position, undergoes displacement in a lateral direction, so that its centre no longer coincides with the centre of the pupil. A curious instance of this malposition of the lens occurred in a mother and three children who came under my care. In the mother, and in one of the sons, both lenses were displaced upwards and inwards; in another son, directly inwards; and in the third, directly upwards. In none of these cases did the lenses deviate, or only in the slightest possible degree, from their normal transparency.*

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* See a description of these cases in *Ophthalmic Hospital Reports*, vol. i. p. 54, 1858; also in my *Guide to the Practical Study of Diseases of the Eye*, 2d edition, p. 401.

CATARACT.

This term, as I have already observed, should be strictly limited to denote partial or complete opacity of the lens or its capsule.

The existence of capsular cataract has of late years been called in question, and I shall presently notice the grounds of this new opinion.

Opacities of the lens do not appear to be all of precisely the same nature. Some depend upon a shrinking and wasting of the fibres themselves, without any appreciable change in their chemical composition, while the more strongly marked and chalky-looking streaks and spots are formed by new deposits of earthy and fatty material.

We shall best appreciate the changes which take place in cataract by glancing at the anatomy of the lens. It is completely enclosed within the very thin, but strong, capsule, which is throughout perfectly transparent and homogeneous. To this capsule is attached the "suspensory ligament of the lens," which passes off from the back of the ciliary processes to be implanted into the capsule of the lens, with which it becomes identified. Immediately within the capsule is a layer of cells; internally to this layer are arranged the superficial fibres of the lens, softer and of a more fragile consistence than those forming the centre or *nucleus*. The fibres of the lens are disposed in planes, the exact arrangement of which cannot easily be understood without the aid of diagrams; it may suffice for our purpose, however, to state, in general terms, that the fibres form radii converging from the circumference to the centre, and are more curved as they are nearer to the anterior and posterior surfaces of the lens, and less curved as they approach its vertical plane.

Such being the manner in which the elements of the lens are arranged, we shall at once perceive the reason why the opacities of cataract present such different appearances, according as they are in the superficial cellular, or the deeper fibrous layers.

When the superficial cells and adjacent soft fibres of the lens become disintegrated and broken up, and intermixed with generally diffused earthy deposits, the whole area of the pupil presents a milky appearance without any regular striæ being visible. If the softening process has been going on for a long time, there is usually an abundant formation of fatty matter, and the faintly-bluish skim-milk colour gives place to a slightly yellow tint, like that of cream.

If, however, the cataractous opacity commences in the unbroken fibres of the lens forming its cortical portion, whitish streaks are seen converging from the circumference towards the centre. In persons past middle life some of these streaks have a slightly yellow cast, while others are perfectly white. This difference of tint depends upon the fact I have already noticed, namely, that the body of the lens, after the age of thirty or forty, acquires a yellow tinge; and consequently, although the opaque streaks are in themselves white, only those appear so which are on the anterior face of the lens, and are viewed through the colourless media of the cornea and aqueous humour; while, on the contrary, the streaks on the posterior face of the lens, being seen through its still transparent, although yellowish, body, acquire a corresponding change of colour. A practised eye will also recognise a difference of form between these two sets of striæ; those on the front of the lens presenting a convexity, and those on the hinder face a concavity, towards the plane of the iris.

These striæ can be clearly seen only in the earlier stages of cataract, for eventually the superficial fibres and cells become broken up and disintegrated, and then the lens presents one uniform whitish or grayish surface.

The fibres of which the *nucleus* consists are denser and firmer than those constituting the cortical portion; but they are disposed in the same radiating form. When this nucleus becomes opaque in old age, it does not present the marked striæ so characteristic of *cortical* cataract, but assumes a more uniformly cloudy appearance. The distinction between the *cortical* and the *nuclear* portions of the lens are best seen in the common form of congenital cataract, in which the whole nucleus is opaque, while the periphery remains almost or quite transparent.

I have briefly alluded to the doubts which some histologists have thrown upon the existence of "capsular cataract"—a term employed even quite recently as designating one of the two grand divisions of cataractous opacities. These doubts chiefly originated with Stellwag,* who, after carefully examining with the microscope about fifty cataracts with apparently opaque capsules, asserts that in every instance the opacity was caused by substances *attached to* the lenticular surface of the capsules, but not *deposited in* the very tissue of the capsules themselves. The opaque material which, to the naked eye, seemed identified with their tissue, chiefly consisted of earthy and fatty deposits, firmly adherent to it, but yet separable by mechanical or chemical means.

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* *Die Ophthalmologie*, 1853-58.

The marbled and mottled appearance commonly described as characterising "capsulo-lenticular cataract" is said by Stellwag to depend upon the irregular manner in which the earthy and fatty material is deposited on the inner surface of the capsule.

Although the facts pointed out by Stellwag and others may justify us in discarding the term "capsular" as designating a species of cataract, it would be affectedly precise to abandon the term *opaque* as applied to a portion of capsule impeding vision, merely because the opacity may be due to earthy or fatty matter adhering to the membrane. And, indeed, a portion of capsule which is transparent and invisible when perfectly tense, will become opaque when relaxed and thrown into folds.

Reverting to the changes in the lens itself, I would observe that a very common error exists with regard to the use of the terms *hard* and *soft* as applied to cataract. These terms are employed as if, in certain cases a softening process set in from the very first, whilst in other cases the reverse took place, and the whole lens underwent a steady process of hardening. But if we examine a healthy lens at the infant period of life, and compare it with one which is congenitally opaque, we shall find but little difference in the consistency of the two structures. In the adult, the lens retains nearly its normal consistency so long as the opacity remains at the striated stage, and it is not until after a considerable period that the superficial portion of the lens undergoes that process of disintegration which imparts to it the uniformly whitish and milky appearance.

Again, in old subjects the commencement of cataract is not attended with any marked hardening of the lens, although, as the nucleus becomes opaque, its fibres appear to undergo a certain process of drying and atrophy. But even in the oldest persons superficial softening eventually sets in, usually many years after the first commencement of opaque striæ.

Hence it will appear that the terms *hard* and *soft* express only a certain stage in the progress of a cataract; that in no form of the disease does the lens from the very beginning undergo progressive hardening; but those lenses which for a long time retain their normal firmness while opacity is advancing, eventually become softened, and may, even in the lapse of many years, undergo a complete transformation into a fluid condition.

Under the two heads, *Nuclear* and *Cortical*, we may arrange all the various forms of cataract; abolishing the old term "capsular cataract," and assigning those opacities which were formerly known by that name to the *cortical* division.

Nuclear cataract would comprise, first, the congenital form of the disease; and, secondly, that which is met with in old age, either alone, or, more frequently, associated with marginal striæ.

Cortical cataract is by far the more usual form; for the opacity which occurs in middle life almost invariably commences in the cortical portion of the lens; and even in old age this is the rule, the rare exception being that the nucleus becomes cloudy before marginal striæ are developed.

It was owing to insufficient exploration of the eye that the reverse of this was formerly believed to be the case; but no one can have had extensive opportunities of examining the eyes of old persons under the influence of atropine, without convincing himself that, even in extreme old age, it is much more common to find marginal opacity beginning whilst the nucleus is still clear, than to find nuclear opacity beginning while the margin of the lens is transparent.

Diagnosis of cataract. There is no better test of an ophthalmic Surgeon's skill than his ability to determine the presence or absence of opacity in the lens. And nothing is more important to be precisely ascertained; for the want of skill to detect cataract in an early stage may lead the Surgeon to regard the case as one of retinal defect; or, on the other hand, he may mistake the reflex of light from the retina for the opacity of cataract.

I will not detain the reader with a long account of the *subjective* symptoms which attend cataract; for the detection of the disease depends wholly upon a careful examination of parts lying open to our observation. A full detail of subjective symptoms is, no doubt, very useful in ascertaining the morbid condition of a structure wholly concealed from our view; but this is not the case with the lens, and if we suspect opacity to exist, we have simply to look for it.

A more or less marked dimness of sight, uniformly involving the field of vision,—coming on gradually, and without inflammation, unattended with any impairment of motory power in the iris,—such would be the symptoms which would make us suspect the existence of cataract. Our examination should be conducted in the following way:

The patient should be placed close to a window admitting bright daylight,—not direct sunlight,—and care should be taken that the light does not fall upon the cornea from more than one window, and that reflections from mirrors and other polished surfaces do not interfere with the single ray which should pass into the pupil. A convex glass of an inch focus should be used as a condenser, to concentrate light upon the surface of the patient's lens, while we explore it with the naked eye. In this manner faint streaks of opacity may be detected, which would otherwise escape us. Each eye must be separately examined.

The contractility of the iris is tested by placing the hand for a second or two close to the eye, and then suddenly exposing it to the light by removing the hand. All particulars as to the patient's range and distinctness of vision for near and distant objects are to be noted; and if the dimness of vision be very trifling, and mere shortness of sight, or deficiency of adjusting power be suspected, concave and convex glasses of various foci should be tried.

We must never rest satisfied with a patient's assurance that he can or cannot read, but must obtain a precise standard of his sight by making him read aloud from type of different sizes.

In hospital practice, those who have not learnt their letters may be told to count dots, point out a single and a double line, an asterisk, and other typographical marks.

All these experiments must be made while the eye is in its natural state. We next proceed to dilate the pupil with atropine. A solution of two grains to the ounce of distilled water is usually strong enough for this purpose, and care should be taken to obtain the sulphate perfectly neutral. Any excess of acid makes the application painful, and so of course does the addition of alcohol, which I have sometimes seen prescribed. The lower lid should be slightly drawn away from the globe, and a few drops of the solution let fall between them; and then the lids should be kept closed for a quarter of an hour or half an hour.

When the pupil is fully dilated, we repeat our examination as before, with the aid of concentrated daylight, carefully illuminating and exploring the extreme margin of the lens, and, if its body be sufficiently transparent, lighting up and examining its posterior surface. In this manner the faintest streaks of commencing cataract may usually be detected; while dense patches along the margin of the lens, opaque striæ converging along its anterior or posterior surface, delicate lines radiating from the centre, or the uniform haze of a cloudy nucleus, can hardly escape detection.

While cataract is still in a very early stage of development, it is so important to ascertain the condition of the retina and choroid, that in every case the ophthalmoscope should be used to complete our diagnosis.

By examining the deep tissues we sometimes detect in them morbid conditions, which would induce us eventually, when cataract had become complete, to abstain from operating; or, if an operation were deemed desirable, it would be undertaken on the full understanding that only partial success would be attainable.

Reasoning *à priori*, we should imagine that the ophthalmoscope would be an infallible means of detecting those faint traces of cataractous opacity which elude the ordinary modes of observation; but experience shows us that, under the strong glare of the ophthalmoscope, these faint opacities frequently disappear, just as a slight flaw in a piece of glass might become visible when laid upon a black surface, although it would not be seen when the glass was held in front of a brilliant light.

In most cases, however, the opaque striæ of a commencing cataract are seen under the ophthalmoscope as radiating black lines, while a hazy nucleus assumes the appearance of a dark cloud in the centre of the pupil.

I have already spoken of the twofold division of cataractous opacities into cortical and nuclear, accordingly as they are situated in the periphery or the centre of the lens. To give any special names to cataracts, in consequence of the various shapes which the opaque deposits assume, appears to be altogether trifling and useless. It is evident that the transparent and opaque elements of a diseased lens may arrange themselves in such a manner as to produce infinite variations of shades and figures, without offering any real variety in their composition. There are, however, a few leading peculiarities, connected with age and mode of development, which demand a separate notice.

CONGENITAL CATARACT.

This opacity may exist in very different degrees.

1. The slightest form is that of a small white central dot on the anterior face of the lens (*cataracta centralis*). This dot consists of a minute portion of earthy matter deposited in the most superficial portion of the lens, just within the capsule. In cases of this kind the rest of the lens commonly remains throughout life transparent, and the patient is often unconscious of any defect of vision. Occasionally, however, a few faint white lines are seen radiating from the central dot. If the rest of the lens remains transparent, this slight form of cataract should by no means be treated by operation.

2. Sometimes, instead of forming a minute central dot, the

earthy deposit is so large as to occupy nearly the whole area of the pupil, when in its contracted state. The deposit projects forwards in the shape of an obtuse white cone, and appears to adhere by its base to the anterior surface of the capsule. This, however, is not really the case, the cretaceous mass being imbedded in the superficial portion of the lens, and covered by the transparent capsule. The term *Cataracta pyramidata* has been given to this congenital form.

3. The most common kind of congenital cataract is that in which the nucleus is opaque, while the peripheral portion remains transparent. In the contracted condition of the pupil this transparent portion is hidden by the iris, but it comes into view when the pupil is widely dilated. In the contracted, or but slightly dilated, state of the pupil, its entire area is occupied by a grayish-white opacity, made up of fine radiating lines, which converge to an opaque white patch at the centre of the lens. When the pupil is widely dilated with atropine, this opacity is seen to be surrounded by a perfectly black area, and through this clear ring-shaped space the patient has tolerably clear vision. Those who examine such cases for the first time are apt to imagine that the opaque nucleus which they see really constitutes the whole lens, shrunken and contracted to an unnaturally small size, and that the dark ring-shaped space is altogether unoccupied by lens-tissue. Occasionally a few white lines are seen to traverse this space, passing from the opaque nucleus to the outer margin of the lens. When such a nuclear cataract is broken up with the needle, in the operation for solution, the real nature of the case is made manifest, and the peripheral portion of the lens soon becomes as opaque as the nucleus itself.

If cases of this kind are not operated upon in early life, the patients, although very short-sighted, continue for many years to enjoy considerable powers of vision; but usually, towards the age of forty, if not sooner, the peripheral portion of the lens undergoes a change, and gradually becomes opaque.

4. A form of congenital cataract, much more rare than that just described, consists of a very faintly striated opacity of the nucleus, unaccompanied by that chalky-white central patch which renders the ordinary congenital cataract so conspicuous and so easy of diagnosis. Several instances have come under my notice, in which this rarer kind of cataract has remained undiscovered until the patients were of an age to be sent to school, when their inability to read ordinary type has caused their friends to seek advice.

5. It is very unusual to find cataract first commencing between infancy and puberty; but I have met with a few cases in which the opacity seemed to have begun when the patients were about nine or ten years old. They had been sent to school at the age of seven or eight, and had readily learned to read; but at the end of a year or two their sight began to fail, they became at first short-sighted, and then gradually lost the power of reading any but large type, or of recognising faces across a room.

I have observed two distinct forms of opacity in these cases.

In one form the lens was dotted throughout with minute white points, arranged in the course of its fibres. These dots were as small as if pricked-in with the finest needle, and the general effect they produced was that of a very faint haziness in the pupil, only recognisable under concentrated light.

In a second set of cases the opacity was wholly confined to the posterior surface of the lens. In some instances there was one isolated patch in that situation, not exactly in the axis of the lens, but reaching from near that point to its extreme edge. In other cases the whole posterior face was covered with very fine opaque lines, closely set together, and converging from the circumference to the centre, so as to produce the effect of a delicate fibrous membrane of concave form. Encircling the exact centre of this opaque surface was a whitish ring, more dense and earthy in appearance than the rest of the striated surface of which it formed a part.

These opacities, limited to the posterior face of the lens, of course require for their detection far more careful observation than congenital cataract of the ordinary kind, in which the whole nucleus is opaque, and the centre probably marked with a chalky-white patch in the very centre of the pupil.

Congenital cataract, whatever form it may assume, is frequently accompanied by a rhythmical twitching movement of the eyeballs, the effect of irregular action either of the recti or the oblique muscles. This twitching is known by the name of *nystagmus*. It does not, however, invariably accompany congenital cataract, some patients suffering from this affection being entirely free from any irregular muscular action; while, on the other hand, *nystagmus* is met with in many cases of defective sight wholly unattended by any opacity of the lens.

There are certain morbid deposits in the deep tissues of the eyeball which in infants and children may be mistaken for the opacity of cataract. Scrofulous and encephaloid deposit, for instance, in their early stage, are not unfrequently mistaken in this manner; but a careful examination, through a well-dilated pupil, cannot fail to detect the real nature of the disease. Both scrofulous and encephaloid deposits have a more or less yellow colour, and by a practised observer will be recognised as lying much further back than the hinder surface of the lens. At a certain stage, however, of scrofulous and encephaloid deposit the lens becomes cloudy; and how, it may be asked, is a secondary cataract of this kind to be distinguished from one which is primary, and unconnected with any other affection of the globe?

In an eye affected with simple cataract the position of the iris is usually vertical, or nearly so; the pupil is active; the lenticular opacity is regularly striated, and perhaps exhibits also at its centre a white dot. In advanced scrofulous and encephaloid disease, on the contrary, the anterior chamber is obliterated, the pupil is irregular, dilated, and fixed; the lens has an uniformly cloudy appearance, and sometimes receives from the mass behind it a somewhat yellowish tint. Congenital cataract, too, almost invariably affects both eyes; while encephaloid deposit almost as invariably occurs in one eye only. Scrofulous deposit does, indeed, occasionally affect both, but rarely to the same extent, or at the same time.*

CATARACT IN ADULTS.

Except as a result of injury, cataract is rarely seen to commence between puberty and the middle period of life. Up to the age of forty it is a rare disease, it becomes more common in patients who have passed their fortieth year, but it is after the age of fifty or sixty that we are more especially on the watch for it in patients complaining of failing sight.

Even up to extreme old age cataract usually commences at the circumference of the lens, in the form of opaque striæ, which gradually advance along the anterior and posterior faces of the lens towards its axis.

About the same time very fine whitish lines may be observed to radiate from the anterior pole of the lens, marking the divisions which exist between the planes in which its fibres are arranged.

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* In children and older persons who have been brought under my notice for congenital cataract, I have been struck with the frequent occurrence of diseased teeth; the incisors and canines being dwarfed, deficient in enamel, discoloured and honey-combed on their anterior surface, and their cutting edge worn away and blunt. I am unable to offer any explanation of this condition of the teeth, which I do not find mentioned by any ophthalmic observer.

After the age of sixty a hazy condition of the nucleus is commonly found coexisting with advanced marginal opacity; but even in extreme old age it is far more common, as I have already observed, for cataract to commence at the margin than at the nucleus.

If we trace the rise and progress of cataract in an elderly person, the changes will usually be found to occur in the following order. First, opaque striæ are formed at the extreme edge of the lens, and commonly it is the lower edge which is thus affected. These striæ gradually coalesce into patches, and then spread themselves over the posterior face of the lens, only a few extending a short distance over the anterior face. At this point of development the cataract may remain stationary for a year, or even for several years. Then a farther change takes place, and the whole body of the lens, but especially the nucleus, becomes slightly hazy, but not so as to prevent the posterior radiated opacity from being recognised when properly illuminated. The opaque striæ on the anterior face of the lens gradually advance until their tips appear within the area of the pupil. The haziness of the body of the lens increases until even concentrated light fails to reveal the posterior striæ, and at last only the anterior surface of the lens can be seen. At this stage of cataract, vision is restricted to mere perception of direct light, or of that reflected from white or polished surfaces. Perhaps bright colours may still be recognised.

Up to this point the fibrous structure of the lens can still be traced; but as years go on, its surface becomes more opaque and whiter, in consequence of disintegration of the superficial fibres, and the deposit among them of earthy and fatty material. Occasionally crystals of cholesterine, just within the capsule, may be recognised by their peculiar sparkling appearance.

It sometimes happens that this final stage of superficial softening does not occur, and the cataract is then very difficult of detection, having a dull brownish appearance like horn.

A very rare form of lenticular opacity is that termed "black cataract." The name is frequently given to lenses which are only of a dark-brown colour, but absolute blackness is sometimes met with. It must not, however, be supposed that in these cases the blackness of the pupil is like that presented by a healthy eye, in which all the humours are perfectly clear. In the two or three cases of black cataract which I have seen, there was not the slightest doubt as to the existence of a cataract, although the blackness, so remarkable after extraction, was not suspected; for, in each instance, several fine whitish lines could be seen radiating on the anterior surface of the lens, formed no doubt by slight earthy deposits just within the capsule.

Fluid cataract; Morgagnian cataract. The softening process, which begins in the superficial portion of an opaque lens, may go on until, in the course of years, the whole mass becomes converted into a thin pulp. The nucleus, for a long time, resists this softening change, and a lens consisting of a firm nucleus, surrounded by a turbid pulp of disintegrated tissue, has received the name of "Morgagnian cataract."*

As in fluid cataract all the superficial portion of the lens is disintegrated, there is of course no trace of those radiating striæ so characteristic of ordinary opacity. Sometimes a fluid cataract is bluish-white, like milk-and-water; in other cases it assumes a dirty-gray colour, or a pale-yellow tint, like that of cream. Its consistence appears unequal, as if some portions were coagulated, and others perfectly fluid.

The creamy colour is usually found in cataracts that have existed in the fluid state for a considerable time, and it seems rather paradoxical to assert that it is very difficult, even for a practised observer, to distinguish between a fluid lens of this kind and one which has undergone a change of a directly opposite character, and become solidified by earthy deposit. The perfectly fluid and the perfectly solid lens are equally devoid of fibrous markings, and the inequality of consistence in the former presents an appearance very similar to that resulting in the latter from the variety in tint, caused by the manner in which the earthy constituents of the solidified lens are deposited on the capsule.

The following are mentioned among the distinguishing signs of a fluid cataract,—an advance of the iris towards the cornea, caused by an increase in the bulk of the lens, attending the fluid change,—and a difference in the degree of opacity in the cataract, as respects its upper and lower portions, caused by the gravitation of its denser particles. But neither of these signs can be relied upon; for in cases of fluid cataract it often happens that the iris deviates little, if at all, from a vertical plane; and the separation of the contents of the capsule into fluid and solid is seldom sufficiently complete to allow of the more solid portions gravitating in the manner described by authors.

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* This form of cataract was not described by the Italian anatomist from whose name the term is derived. In dissecting the eyes of animals he had observed a fluid to exude from between the capsule and the lens, and concluded that this fluid always existed during life. In compliment to the discoverer it was termed by anatomists *liquor Morgagni*, and its existence in the living eye was for a long time regarded as indisputable; subsequent observation, however, has proved it to be a product of *post-mortem* decomposition. Morgagni has been, as it were, quoted against himself; for, in treating of the causes of cataract, he suggests that the disease may originate in a deficiency of this very fluid, whereby the lens, he thinks, would become dry and opaque. His words are: "Tunicâ in vitulis etiam, bobusque, sive recens sive non ita recens perforatâ, pluries animadverti illico humorem quendam aqueum prodire: quod et in homine observare visus sum, atque adeo credidi *hujus humoris* secretione prohibitâ, crystallinum siccum et opacum fieri, fere ut in extracto exsiccatoque crystallino contingit." (*Adversaria Anatomica*, &c., Lugd. Bat. 1741, Adv. vi. p. 90.)

If a fluid cataract is examined with the microscope, the lens-fibres are found in every stage of disintegration, mixed up with earthy matter and a multitude of oil-globules.

TRAUMATIC CATARACT.

The lens may lose its transparency in consequence of a blow on the eyeball, although its coats may not be ruptured, or the lens itself displaced from its connexions, the mere shock being sometimes sufficient to affect the nutrition of the lens, and induce a gradual opacity of its whole substance.

Any penetrating wound of the lens is sure to produce cataract, and if the wound in the capsule remains open, so as to allow the superficial cells and fibres of the lens to imbibe the aqueous humour, the whole mass gradually becomes disintegrated and absorbed, so that eventually a wounded lens may wholly disappear without any surgical interference. It was a knowledge of this natural process that first suggested the operation for the cure of cataract by *solution*. It is only in exceptional cases that the whole lens becomes absorbed in consequence of a wound. More commonly it happens that a certain portion of lens-tissue remains enclosed within the capsule, and undergoes fatty change. The following is the appearance such a traumatic cataract would present some years after the occurrence of the injury.

There is probably some adhesion of the pupillary margin to the capsule, the result of old iritis; the pupil is occupied by a disk, formed by the approximation of the anterior and posterior surfaces of the capsule, enclosing between them some remains of very opaque lens-tissue. This disk is situated much further back than the position occupied by a full-sized lens, and its dead-white patchy area not unfrequently exhibits some glistening crystals of cholesterine.

In cases where the wound of the lens has been followed by a considerable amount of iritis, the whole margin of the pupil may be found adherent to the anterior capsule, which may also be coated with a dense membrane, composed of old lymph. The pupillary area may be small, and not susceptible of increase by the use of atropine, on account of the intimate union between the iris and the capsule. Occasionally there is a deceptive appearance of a partial opening of the pupil, and a casual or inexperienced observer will suppose that a sufficient portion of the pupil is free to allow of useful vision. The supposed aperture, however, is really a patch of black pigment, lying in the whitish membrane which is closing up the pupil. Light, concentrated on the part by means of a lens, will almost always reveal the true nature of the supposed aperture, or, should this means fail, the ophthalmoscope will at once resolve the doubt.

It would be impossible to describe all the various appearances presented by the pupil after the partial or complete absorption of a wounded lens. The capsule may block up the entire space in the manner just described; it may form a delicate filmy net-work, hardly visible except under concentrated light; it may have been completely torn through at its centre, the peripheral portion retracting all round, so as to form a white ring, almost hidden by the iris; or it may assume the appearance of a single white band stretched across the pupil from side to side. In short, there is hardly any possible variety of figure which the opaque capsule may not assume.

It never undergoes absorption, but it often appears to do so, in consequence of the manner in which it retracts and shrinks together when divided. This retractile property of the capsule should always be borne in mind by the Surgeon, in the various delicate operations which become necessary when an opaque portion of it is obstructing the pupil. He should take care not to isolate any part of the opaque membrane, but to regulate his incisions and lacerations of it in such a manner that it may always have a fixed point at the periphery, towards which it may retract, and so leave the central portion of the pupil free.

Dislocation of the lens into the anterior chamber. This accident takes place as a result of external violence, such as a blow upon the eyeball, or a violent fall. It more frequently happens when the lens has been long in an opaque condition, and its suspensory ligament weakened, or partially detached by disease. The appearance of an opaque lens in the anterior chamber is so peculiar, that the nature of the accident can hardly be mistaken. When the lens is dislocated in a transparent state, its margin presents the appearance of a ring of golden light. Pain and inflammation set in very soon after the occurrence of the accident, and loss of the eye can be averted only by prompt removal of the lens, through a suitable opening in the cornea.

I have already spoken of certain forms of partial displacement of the lens, when treating of the inflammation such accidents give rise to (see the section, Traumatic Iritis, p. 737); and have considered "subconjunctival dislocation of the lens" in the chapter on Affections of the Sclerotic (p. 730).

TREATMENT OF CATARACT.

Before describing the treatment of cataract, I may be expected to say something respecting the morbid agencies which give origin to it. But, in truth, the causes of cataract, whether remote or proximate, have hitherto received no satisfactory explanation. The fact that the lens may be opaque at birth, or may become so in old age, at once proves under what widely different conditions the disease is developed; and we need but cast a glance at the varying and even opposite theories which have been given as to the predisposing causes of cataract, to convince ourselves they are but guesses, for the most part fanciful and unfounded.

Thus, one author thinks that persons exposed to the heat and glare of strong fires are predisposed to cataract; another makes the same remark of those who drink sour wines; by a third, the prevalence of cataract among the Turks is attributed to their using opium; while other observers consider that the inhabitants of volcanic countries are peculiarly liable to the disease. Certainly, in its senile form, cataract is common enough among our own agricultural labourers, who know nothing of sour wine, and very little of opium, are not incommoded by over-large fires, and never saw a volcano.

The truth seems to be, that, in all countries, cataract is a frequent accompaniment of advancing years; and neither social position nor peculiarity of employment exempts the aged from being liable to it.

Can cataract be cured without an operation? This question will be answered in the affirmative by hosts of quacks, who, for their own selfish ends, avail themselves of that shrinking from any thing bearing the name of an operation, which is a natural instinct in us all; and pretend, by means of liniments, or drops, or the still more scientific-looking galvanic battery, to turn opaque lenses into clear ones.

It would be presumptuous and absurd to pronounce absolutely, that no cure for cataract, short of a surgical operation, can *ever* become possible. But certainly nothing approaching to such a cure has hitherto been discovered.

The Surgeon must constantly be on his guard against being too much impressed with the mere existence of opacity in the lens, as if it were altogether an independent disease.

Various inflammatory conditions of the eyeball may eventually produce cataract, but in such cases there are usually some signs of disease in other tissues, as well as certain peculiarities in the position or appearance of the lens itself. Old adhesions between the pupillary margin and the anterior capsule,—a bulging forward against the cornea of the iris and lens, or their receding too far backwards, so as to produce an unnaturally large anterior chamber,—an irregularly dilated and fixed pupil,—a tremulousness of the lens whenever the recti muscles are put in action,—total loss of perception of light,—such are the more striking conditions which at once would lead us either to regard a cataract as unsuited for operation, or at least would induce us to institute searching inquiries into the earlier history of the case.

It must always be remembered that simple opacity of the lens, however far advanced, never deprives a patient of perception of light, provided the retina is sound. Indeed, in the great majority of instances, a patient with no other disease in the eye but an opaque lens, will not only readily perceive the shadow of a hand, or other object, passing between him and the sky, but, with his back to the window, will perceive the light reflected from a sheet of paper, although he may be quite unable to detect the form of the reflecting surface. Many patients, with densely opaque lenses, will, in the same position, recognise well-illuminated coloured surfaces, such as bright red or yellow, or will even discriminate between yellow and white. If, in addition to this perceptive power, the iris maintains its vertical plane, the pupil is round and active, the cornea brilliant, the consistency and movements of the globe perfect,—the Surgeon may regard the cataract as suitable for operative treatment.

Long experience and observation will give to the Surgeon a certain empirical tact in determining whether a given case of cataract is, or is not, fitted for operation. He recognises at once the difference between an eye which has passed through inflammatory stages, and one in which simple opacity of the lens is present. In the latter case, however dense the cataract may be, the patient has a certain expression of *trying to see*, quite different from the manner of one who merely turns his eyes this way or that, at the command of the Surgeon.

In all cases the pupil should be dilated with atropine before the Surgeon finally resolves to operate, so that no concealed adhesion between the iris and the capsule may remain undetected.

OPERATIONS FOR CATARACT.

These may be arranged under three heads: *depression*, *solution*, and *extraction*.

1. In *depression*, or "couching," as it was formerly termed, the lens is thrust from its natural position in such a manner that, although still within the eye, it may allow the rays of light to pass unimpeded through the pupil to the retina.

2. The operation by *solution* or *absorption* grew out of that by depression; for it was found that if, in the attempt to depress the lens, it accidentally became much broken up, the fragments gradually dissolved and disappeared; and hence it occurred to certain thoughtful observers that this absorbent power in the system might be taken advantage of in such a manner as to avoid the dangers inseparable from the old operation of "couching." Hence arose *discission* or *division* of the lens, since modified into the operation by "solution."

3. In *extraction* the opaque lens is removed bodily out of the eye, through a wound made for that purpose in the cornea.

OPERATIONS BY DISPLACEMENT OF THE LENS.

(*Depression; Reclination.*)

Those who are interested in the early history of ophthalmic surgery will find the older descriptions of cataract, and the operation for its cure, wholly unintelligible, unless they are acquainted with the views of the ancients respecting the anatomy of the eye.

Even so late as the time of Vesalius it was believed that the lens occupied the exact centre of the globe, and it is so figured in that anatomist's work, *De Corporis Humani Fabricâ*, 1555, p. 798, where it is placed exactly midway between the iris and the junction of the optic nerve with the retina; the posterior chamber of the aqueous humour, and the chamber of the vitreous humour being precisely of the same extent. Such a position of the parts would of course afford ample space for an opaque *humour* to collect, and form the supposed "cataract" between the lens and the iris.

It is a curious fact that, while the operation of "couching," or depression, had been practised from very early times, each successive generation of Surgeons firmly believed that what they depressed was not the lens,—which, indeed, they believed to be the immediate seat of vision,—but a skin, or coagulated film, in front of it. Ambrose Paré, the most celebrated Surgeon of his day, after describing the mode of introducing the needle through the sclerotic, and depressing the cataract, adds, "en faisant telle chose se faut bien donner garde de toucher à l'humeur cristalin, pource que, comme nous avons dit, il est le principal instrument de la veüe."*

It was not until the latter part of the seventeenth century that the real nature of cataract was understood; and some of the old oculists, who had passed their lives in depressing lenses without knowing it, were furious at the new-fangled theory of cataract being the opaque lens itself.†

The early Surgeons, therefore, who, from time immemorial, had taught the operation of depression, however they may have erred in *practice*, through their ignorance of the real pathology of cataract, acted in perfect accordance with their own *theory* of its nature; for such a membrane as they believed a cataract to be, when once thrust fairly away from the pupil, would not have been likely to set up irritation. One can less readily understand how, after the real nature of cataract had become known, operators could still imitate the old manipulations, and persuade themselves that so bulky a body as the lens could be displaced in such a manner that it should not press upon, or interfere with, any of the delicate tissues surrounding it.

To pass a needle through the sclerotic, until its point arrived at the upper edge, or the front surface of the opaque lens, which was then thrust downwards, or backwards and downwards, and embedded in the vitreous humour, appeared a real triumph of surgical skill; so instantaneous was the benefit conferred by the operation, and so trifling the pain of its performance. The patient was in a moment restored to sight, and the smallness of the wound seemed to obviate all risk of inflammation. And, no doubt, depression, or the modified form of it, termed reclination, in which the lens is turned over on its posterior face, instead of being thrust vertically downwards, would be a very perfect operation, if it were possible to insure the lens being conducted to the position so neatly figured in diagrams, where it reposes in the vitreous humour, quite out of the way of the pupil, and close to, but never touching, the retina or ciliary processes.

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* *La Méthode curative des Playes*, &c. Paris, 1561.

† This Woolhouse, an oculist who, in spite of his gross ignorance, was the leading operator of his day, was most indignant when Brisseau, appealing, in proof of his assertion, to dissections of cataractous eyes, declared the lens to be the seat of cataract. Facts were against Woolhouse; —" tant pis pour les faits!"

But how is the lens to be so placed in reality? Even if the whole eyeball were as transparent as the cornea, so that the Surgeon could keep the point of his needle in view throughout every stage of the operation, how could he deposit the lens precisely in the position I have mentioned? Or, if he succeeded in leaving it in the very spot he had intended, below the pupil, and yet above the retina, how could he insure its remaining there? how prevent its sinking downwards, so as to come in contact with the retina, or falling forwards against the ciliary processes and iris, where it must act as a foreign body, and set up irritation which nothing could subdue?

Depression, the oldest form of operation by displacement, was performed in the following manner. The patient was seated, and the Surgeon sat facing him. An assistant, standing behind the patient, steadied the head and raised the upper lid. The needle being thrust through the sclerotic, a little below the equator of the eye, and a short distance from the edge of the cornea, was to be carried between the iris and lens, until the point of the instrument appeared in the area of the pupil. It was thrust on as far as the upper part of the lens, which was then pressed directly downwards, until it descended below the ordinary level of the pupil. It must be evident to any one familiar with the anatomy of the eye, that a body so large as the lens could not be made to descend vertically to any considerable extent, without coming in contact with the ciliary processes; but we must remember that the old oculists performed their operations without the aid of mydriatics, so that they could press the cataract out of sight without forcing it to descend so low as would be necessary to make it disappear from an artificially dilated pupil. Still, there can be no doubt that they frequently thrust the opaque lens either against the ciliary processes or against the retina, and hence the "inflammation," which was looked upon as almost a natural consequence of the operation.

To obviate the danger consequent upon depressing the lens directly downwards, the operation of *reclination* was devised, whereby the lens was pressed in a direction backwards, downwards, and a little outwards. The needle was passed on until its lance-shaped head appeared in the area of the pupil, as in the operation of depression; but the flat of the instrument was placed on the anterior face of the lens, a little above its middle, and steadily pressed against it, until the lens was forced to quit its natural position, and sink down into the vitreous humour. Here it was to be left, with its anterior surface directed upwards, its posterior surface downwards; close to, but not touching, the retina; its lower edge towards, but not in contact with, the ciliary processes; a state of things often figured in diagrams, but rarely, I should think, effected in practice.

The close approximation of the pupillary margin to the anterior capsule of the lens must render it almost impossible to pass an instrument between the two structures without wounding either one or the other of them. In fact, the capsule is usually opened, and undergoes still farther rupture in the attempt to dislodge the lens. No doubt this accidental rupture of the capsule and lens would, in some degree, obviate the dangers of the operation, inasmuch as a lens thus partially broken up would have some chance of undergoing absorption, which would not take place if the lens, according to the idea of the operation, were displaced, still enclosed in its unbroken capsule.

If chronic change should have occurred in the suspensory ligament of the lens, the cataract enclosed in its unbroken capsule might sink at the first touch of the needle, especially if the vitreous humour had become unnaturally diffluent; but if no such changes should have taken place, the vitreous humour would offer great resistance to this reclination of the lens; and, accordingly, various plans have been suggested for facilitating the reclination by certain preliminary manœuvres. It was proposed, for instance, as soon as the needle had pierced the coats of the eyeball and entered the vitreous chamber, to carry the point to the back of the lens, for the purpose of lacerating the posterior capsule; then the point was to be carried round to the anterior capsule, which was to be lacerated in a similar manner, and it was not till after this preparation that the Surgeon was to displace the lens itself.

Other operators, finding that the elasticity of the healthy vitreous humour was an obstacle to the passage of the lens through it, suggested that the needle should first be passed to the spot where the lens was finally to be lodged, and that a bed should there be prepared for it by the disintegration and breaking-up of the cells of the vitreous humour; and to this bed the lens was finally to be conducted by the needle applied to its anterior surface.

Descriptions of all these manœuvres read very well; but to carry them into effect is a very different matter. It must be remembered that while the point of the needle is lacerating the posterior capsule, or making a soft place in the vitreous to receive the lens, the instrument is wholly concealed from the Surgeon's view, and is within a few lines of the most delicate and important structures. What risk must there not be that, while endeavouring to break up the cells of the vitreous, or lacerate the capsule of the lens, the Surgeon may all the while be tearing up the ciliary processes, or even the retina itself!

To evade the difficulty of displacing a cataract by mere pressure with the flat of the needle, some operators have proposed that, instead of carrying the instrument between the iris and the anterior capsule, its point should be thrust fairly into the substance of the lens, which would then be easily displaced, and carried downwards and outwards into the vitreous humour; the needle being disengaged by rotating it. Two difficulties, however, must attend this operation, the risk of driving the lens before the instrument in the attempt at transfixion, and of pressing the lens against the retina in endeavouring to disengage the point of the needle.

But even supposing that the Surgeon succeeds perfectly in accomplishing the object he has proposed to himself, and, by depression or reclination, modified by any of the methods I have described, has displaced the cataract from the axis of vision, and sunk it in the vitreous humour, without inflicting injury either on the ciliary processes or the retina,—what has he done? He has deposited a large foreign body,—for as such we must regard a cataractous lens detached from its organic connexions,—in close proximity to the retina. How can he insure the foreign body's remaining suspended in the vitreous humour, without coming in contact with surrounding parts? Will not the vitreous cells in the immediate neighbourhood of the cataract undergo gradual disintegration, and allow it to come into contact with the retina, or fall forwards against the iris?

No doubt these would be the almost invariable results of depression and reclination, were it not that, in the attempts to displace the lens, it very commonly becomes a good deal broken up; and this very accident it is which predisposes the lens, after it has been displaced, to undergo absorption. The ultimate issue, however, of most operations of displacement is sufficiently bad to justify my assertion, that it is essentially an unscientific and rough proceeding, calculated to set up a chronic state of inflammation in the deep tissues of the eye, which is in its very nature uncontrollable, inasmuch as the exciting cause, the displaced lens itself, cannot be removed.

Inexperienced persons who witness an operation of displacement, are apt to admire the rapidity and apparent ease with which it is performed, and the immediate restoration of sight which takes place; and they contrast it, perhaps, with the extensive wound made in extraction, the accidents that occasionally attend it, and the slow after-progress towards useful vision. But these appearances are deceptive; every bystander can see the difficulties and mishaps that attend extraction, but in depression or reclination, if only the cataract disappears from the pupil, every thing seems to have succeeded. The damage that may have been inflicted on deep-seated parts cannot be detected, and it is only in following up the case that their result becomes appreciated, in the slow and insidious changes within the globe, which, many months after the operation, may terminate in utter loss of sight. In such cases we hear how well the operation succeeded,—how perfectly the patient saw, till, unfortunately, inflammation set in, and, in spite of every thing being done that medical skill could suggest, destroyed the sight. And why did "inflammation set in"? Either because structures essential to vision had been injured by some wound in the dark during the operation, or because a foreign body had been left in contact with them, to set up in due time an uncontrollable process of disorganisation.

OPERATION BY SOLUTION OR ABSORPTION.

I have said that this operation grew out of that by depression; and it is only surprising that some of the older Surgeons, who had been struck by the manner in which fragments of the lens, accidentally detached during their attempts at depression, became spontaneously absorbed, did not discover that this law of absorption might be applied to the removal of the whole lens.[*]

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[*] Thus Pott, writing in 1775 on the subject of depression, says, "When the opake crystalline is in a state of dissolution, or the cataract is what is called perfectly soft, if the capsula of it be freely wounded by the couching-needle, the contents will immediately issue forth; and mixing with the aqueous humour will render it more or less turbid; sometimes so much so as to conceal the point of the needle and the iris of the eye from the opera-

When this law began to be understood, Surgeons fell into the mistake of supposing that the more completely the lens was broken up at first, the quicker would absorption go on; and they therefore endeavoured to cut up the whole lens into fragments, by what was termed the operation of *discission.* This complete breaking up of the lens seems still to find favour on the Continent; for the true principles of the cure by solution, as taught by Saunders, Tyrrell, and other English Surgeons, seem never to have crossed the Channel in any great force. The cure of cataract by solution is one of the most perfect and beautiful within the range of surgery. It is based on the law, already alluded to, that if the capsule be lacerated so as to expose the tissue of the lens itself to the macerating influence of the aqueous humour, the cells and fibres of the lens, by gradually imbibing this fluid, become broken up and dissolved; and are then so completely absorbed, that at the end of a period varying in duration according to the consistence of the lens and the absorbent power of the patient, every vestige of cataract will have disappeared. In fact, provided the patient's constitution be vigorous, and the lens be not too freely broken up at any one time, it is quite possible to effect the absorption of a cataract in an old person, even up to the age of seventy. But, inasmuch as in such persons cataract usually advances simultaneously in both eyes, the slow process of absorption is found to be wearisome and inconvenient, and liable to be interrupted by slight inflammatory attacks; and as the operation requires to be frequently repeated, the more rapid cure by extraction is to be preferred.

The leading principle to be observed in all operations for the solution of a cataract, is, not to oppress the eye with more broken-up lens-tissue than the absorbing power of the organ is capable of

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tor. . . . . The aqueous humour, however turbid it may become, will in a very short space of time be again perfectly clear; and if no disorder of the capsula of the crystalline, previous or consequential, prevents, the rays of light will pass without obstruction through the pupil, and the patient will be restored to as perfect vision as could have followed the most successful operation of either, or of any kind, in the same subject and under the same circumstances." He adds, "I have sometimes, when I have found the cataract to be of the mixed kind, not attempted depression, but have contented myself with a free laceration of the capsula; and having turned the needle round and round between my finger and thumb, within the body of the crystalline, have left all the parts in their natural situation; in which cases, I have hardly ever known them to fail of dissolving so entirely as not to leave the smallest vestige of a cataract." (*Chirurgical Observations,* &c. 8vo, 1775.)

rapidly removing. If this rule be neglected, the numerous fragments act as so many foreign bodies; inflammation is set up in the iris and cornea, and then all absorption is at once arrested. The conjunctiva and sclerotic become injected; there is pain in and around the eyeball, with intolerance of light and lacrymation; the aqueous humour is turbid, and the epithelial surface of the cornea dull and uneven.

Operation on infants. The breaking up of the lens, if carefully performed, is so devoid of danger that it should by no means be deferred on account of the tender age of the child; on the contrary, by operating early there is a greater probability of obviating those twitching movements of the globes (*nystagmus*), which so frequently attend congenital cataract. Of course, if the infant were extremely puny and ailing, affected with diarrhœa, or in any way weakened by temporary derangement of health, the operation should be deferred for a while, until the absorbent power had been restored; but it is desirable not to wait until the irritation of teething sets in.

The needle I prefer for most of the operations on the lens has a small lance-shaped head, and the relative proportions of the head and the shaft of the instrument should be exactly such as will allow of the shaft playing with perfect freedom in the aperture which the head has made. If these proportions are not accurately preserved, and the shaft is made larger, with the view of preventing the escape of the aqueous humour, it becomes wedged in the wound, and all movements of the point are difficult and constrained. A needle of a larger size than that used for the ordinary operation on infants is very useful in breaking up the capsular obstructions which remain after the lens-tissue has become absorbed, as the head may be of such a size as to allow of its convex edges being made to cut.

All cataract operations are best performed on patients lying down. It was, I believe, at the Moorfields Hospital that this position was first adopted for all such operations, and it has since been introduced upon the Continent, where, a few years ago, patients always underwent the operation for cataract in a sitting posture. Infants are best secured by swathing them from the chin to the feet in a round towel. An assistant steadies the head by placing a hand on each side of it; the lids are kept apart with a spring speculum, and sometimes it becomes necessary for a little fold of the conjunctiva, just beneath the cornea, to be nipped up in a forceps, so as to steady the eye. If the operator contents himself with using a single needle, he can himself with the other hand use the forceps; but if he prefers a more complete laceration of the lens by the use of two needles at once, he must of course intrust the forceps to the hands of a second assistant.

And here I may observe, that the rule I have mentioned, as so important to bear in mind,—namely, to avoid attempting too much at the first operation for solution, admits of an exception in the case of congenital cataract in *infants*. During the first few months of life, the lens is so soft in texture,—it so readily imbibes the aqueous humour, and undergoes dissolution, and the absorbent power is so active,—that the lens may be freely torn up in every direction without the same risk of iritis and other inflammation, as would attend a similar disintegration of it in an older child or an adult. During the operation for solution on an infant, I have frequently seen the entire lens shell out of its capsule, and slip forwards into the anterior chamber, without any inflammation taking place, the lacerated lens speedily undergoing complete absorption.

Previous to any needle-operations for cataract, the pupils should be dilated with a few drops of solution of atropine, applied an hour or so previously.

The needle is to be introduced through the cornea* close to its junction with the sclerotic, and carried on until its point reaches the centre of the pupil. Then the anterior capsule is to be freely lacerated in various directions, and the body of the lens broken up, and the needle may be carefully passed quite through it, so as to lacerate the posterior capsule.

If two needles are used together, the first should be passed in until its point reaches the middle of the pupil, before the second one is introduced through the cornea.

In an infant with congenital cataract both eyes may be operated upon at once; but in an adult the worse eye, if there be any difference, should be operated on first, so as to leave the patient one partially useful eye, while the process of solution, with the temporary loss of sight which it involves, is going on.

After the operation both eyes should be kept closed by means of a light bandage, or strips of plaster on the eyelids, for twenty-four hours, by which time the little wounds in the cornea will have closed.

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* I am assuming that all operations for solution of the lens, and for removal of capsule, are to be performed by *keratonyxis*. Formerly the needle was always passed through the sclerotic (*scleronyxis*); but the operation through the cornea, allowing, as it does, the point of the instrument being always kept in view, is evidently to be preferred.

If the lens has been effectually broken up, and the infant is in good health, a few weeks will sometimes suffice to insure the absorption of the entire cataract; and the capsule, gradually retracting towards the periphery, will ultimately form a white ring almost or altogether concealed by the iris when the pupil is contracted.

But it is not always possible to effect this complete dispersion of the cataract by a single operation, and the capsule, enclosing between its layers a certain amount of unabsorbed lens-tissue, remains as a chalky-white disk, blocking up the pupil and preventing all useful sight. In such cases the two needles must again be employed, and the central portion of the opaque membrane torn through to the desired extent; or, in some cases, it may even be necessary to introduce the cannula forceps through an opening made in the cornea, and extract the capsule entire. This latter proceeding, however, should never be resorted to if a good central opening can be effected by means of the needles only, for in spite of every precaution, the pupillary edge frequently becomes adherent to the wound made for the introduction of the forceps; or else the traction of the iris, to which the capsule often adheres, causes subsequent distortion and deformity of the pupil.

Operation on children and adults. The cataracts which come before us in children, and in persons under thirty years of age, are very commonly those of the congenital form, which had been overlooked during the period of infancy. For it is rare to meet with instances in which cataract *begins* to be developed in childhood, or in the early years of adult life. The operation for the solution of cataracts of this kind is the same as that I have just described on the infant, with this important exception,—that in the older subjects we must take care not to set up irritation in the eye by too extensively breaking up the lens at first; least of all must we be indifferent to the risk attending the accidental displacement of the lens into the anterior chamber, an accident which, as I have said, may happen in the infant without any bad results.

In the first operation on an adult, the Surgeon should not do more than freely break up the anterior capsule to an extent equal to the area of the pupil when not under the forced dilatation of atropine, and disintegrate the superficial portion of the lens, without disturbing the nucleus. This may be done with a single needle, the spring speculum being used or not, according to circumstances. When aided by a skilful assistant, the Surgeon may often dispense with the speculum; but it is usually more convenient to employ it, and its use will enable the Surgeon to perform the operation alone, if no assistant is at hand.

In using the needle, the Surgeon is always to begin to act with the point upon the central portion of the lens ; and in all subsequent operations he is to work from the centre, endeavouring to effect an opening in this situation quite through the lens and posterior capsule, leaving a ring-like portion of both, to be dealt with, if necessary, by a final operation with two needles.

If, instead of beginning to attack the lens at the centre, the Surgeon uses the needle at random, and breaks up the lens at the circumference, he will probably set loose some portions of capsule, which will afterwards wave to and fro in the pupil, and be a most serious impediment to the final success of the case.

After the operation both eyes must be kept closed for twenty-four hours, at the end of which time the needle-wound is usually closed, and the aqueous chamber refilled. From the second day it will only be necessary to close the operated eye, and after a few days a shade may be substituted, and then that may be laid aside for a pair of tinted glasses. The day after the operation atropine should be reapplied, and its use continued so long as any sclerotic zone remains, or so long as the swollen and macerated lens threatens to press upon the iris. Day by day the white flocculent lens-tissue continues to exude through the opening in the capsule ; and if the pupil is not kept well dilated, so as to make room for the increasing bulk of the lens, the iris will become inflamed, and pain will be set up in the eye.

No absolute rule can be laid down as to how often and at what intervals it will be necessary to repeat the needle-operation. In exceptional cases I have known a single operation suffice for the total absorption of the lens in an adult. More commonly, it is necessary in children and young persons to repeat the disintegration of the lens a second time, at an interval of some months after the first operation, and a finishing touch with the needle may subsequently be required thoroughly to clear the pupil from capsule. It is important not to be premature in performing this final operation on the capsule, for during the process of absorption it undergoes so many changes of position by shrinking, that time should be allowed for it to settle into its permanent position before the final laceration of it is made.

If, from peculiar circumstances, it be thought advisable to procure the solution of the lens in an elderly person, or in one whose power of absorption is very feeble,—or in a case where the lens is of that peculiar waxy consistence which renders it so little disposed to imbibe the aqueous fluid, and become loosened up and flocculent, the Surgeon must be prepared to use the needle more frequently; for, in these instances, solution proceeds at a very slow rate, only just that quantity of lens-tissue which is crumbled off at the time of the operation being absorbed, and then no advance is made until a fresh portion of the lens is dug out.

Under these conditions, it may be necessary to employ the needle every two months; and if slight attacks of inflammation occur to interrupt the process of absorption, even longer intervals must be allowed, so that a twelvemonth or more may elapse before a perfectly clear aperture through the centre of the lens is obtained.

In an adult it sometimes happens that, either on account of the lens having been too much broken up at once, or in consequence of the absorbing power having been checked by inflammation, the eye becomes oppressed by the displaced fragments of lens; the sclerotic and conjunctiva then become injected, there is intolerance of light and profuse lacrymation, the iris becomes discoloured, the aqueous humours turbid, the cornea hazy and uneven on its epithelial surface. When these symptoms set in, the eye will be lost by chronic inflammation, unless it be forthwith relieved from the pressure of the swollen lens. The lids being separated with the spring speculum, and the globe steadied with a forceps, an incision is to be made in the cornea close to its margin, and through this a small scoop or spatula is to be introduced into the anterior chamber. The softer pulpy portion of the lens will then escape along the groove of the scoop, or by the side of the spatula when it is rotated; and if this operation has been resorted to in time, an eye which had presented all the phenomena just described may be speedily restored to a healthy state, and that portion of the lens which has been left *in situ* will steadily undergo complete solution.

When a perfectly *fluid cataract*, or one which has to a very great extent undergone the fluid change, is operated on with the needle, it almost invariably happens that distressing nausea and violent vomiting set in immediately; and in some cases I have known this state of sickness, attended with intense neuralgia, to continue for twenty-four or thirty-six hours. As soon as the capsule is punctured with the needle, a puff of creamy fluid takes place into the anterior chamber, and a farther escape of this fluid conceals the iris from view. If nothing farther is done, the distressing sickness is almost sure to set in; but if the Surgeon gently withdraws his needle and immediately introduces at the same spot a broad cutting needle, or the point of a cataract knife, and rotates the blade, the whole of the milky fluid is evacuated, and the sickness is wholly or to a great extent averted. The nausea is best combated by allowing the patient frequently to swallow small fragments of ice; and the neuralgia in the ophthalmic division of the fifth nerve will probably yield to the application of chloroform liniment, applied by means of lint to the forehead and temple.

Operations on opaque capsule. It sometimes happens that, in breaking up a cataract with the needle, the anterior and posterior portions of the capsule are so effectually lacerated, that they retract sufficiently to leave the area of the pupil unobstructed; but these are exceptional cases, and usually, after the lens-tissue has been wholly absorbed, there remain some portions of opaque capsule, which must be removed before the cure can be considered complete.

Capsular obstructions are likewise met with after extraction of the lens; and it seems desirable, therefore, to defer the consideration of them until the operation of extraction has been described.

OPERATION BY EXTRACTION.

The solution and absorption of a cataract in an old person is an extremely slow process, partly on account of the density and impermeability of the nucleus of the lens, and partly in consequence of the diminished activity in the interchange of material which characterises the tissues of the body in old age.

A more rapid removal of the opaque lens, therefore, becomes desirable; and although special circumstances may induce the Surgeon to employ the operation for solution in patients above fifty, or even sixty years of age, he will find it preferable, in the great majority of instances, to have recourse to extraction.

The operation, as now practised, cannot be said to have originated with any one Surgeon, but to have been gradually perfected from a very rude beginning. Daviel has the credit of having performed extraction for the first time during the earlier half of the 18th century; and he professed to have derived the first hint of the operation from his countryman Petit, who, in 1708, had made an opening in the cornea to give exit to a dislocated lens. But Daviel's clumsy and complicated proceeding can only be regarded as a very rough approximation to the delicate operation of the present day. He first, with a lancet, punctured the cornea near its lower edge; then he enlarged the wound with a narrow knife, blunt at the end, but cutting on each side; and, lastly, completed his incision with scissors. Other Surgeons simplified the operation by making the section with a knife only; they continued, however, to do this at the lower part of the cornea, a situation very unfavourable for quick union, inasmuch as the edge of the corneal flap was liable to catch against the lower tarsus, and so become displaced. B. Bell seems to have been one of the first to suggest the practicability of the upward section; but it is difficult to say by whom this great improvement in the operation was really established. It seems to have made its way by slow degrees, commending itself to several independent operators by its evident superiority.

It is to Beer that we appear to owe, if not the invention, at least the systematic introduction, of the knife which still bears his name, and has superseded all other instruments for making the corneal section. This, however, Beer continued to make in a downward direction.

But it was not exclusively, or chiefly, by means of improved instruments, or by greater skill in using them, that increased success in the operation of extraction was to be attained.

The astounding plan of after-treatment which so long prevailed, and the remains of which still linger among us, makes us wonder, not that so many eyes were formerly lost after extraction, but that any were saved. Low diet, carried to the verge of starvation,—profuse bleeding, both general and local,—active purging and mercurialisation, and long confinement to dark rooms,—formed a course of discipline by which Surgeons hoped to heal a wound inflicted on a structure devoid of blood-vessels, and peculiarly liable, therefore, to slough or ulcerate whenever its vitality was lowered by any exhausting agencies. These Surgeons saw the cornea die in persons worn out with scarlet-fever, erysipelas, small-pox, or typhus; and yet, in the after-treatment of extraction, they seemed bent upon reducing the patient as near as possible to the same condition as those diseases would have done.

I shall have occasion hereafter to speak of the after-treatment of cases of extraction; at present we have to consider the operation itself.

The objects to be kept in view are the following:

To make a crescentic opening in the cornea sufficiently large to afford an easy exit to the lens. To make the incision at such a distance from the sclerotic as to insure both edges of the wound being wholly of corneal tissue; for wounds of the true cornea, provided their edges are in perfect apposition, have a peculiar readiness to unite,—a property not equally shared by that extreme marginal portion of the cornea which blends with the sclerotic. Freely to lacerate the anterior capsule, so as to allow of the lens readily slipping through the rent when pressure is made on the globe. Lastly, to apply this pressure in such a manner that the lens may be made slowly to turn on its transverse axis, and thus to present its upper margin first at the pupil, and then at the corneal wound.

If we reflect, that the Surgeon's object is to dislodge and press out the lens, at the same time that he avoids pressing out any portion of the vitreous body, it must be evident that extreme care and delicate handling are necessary. The pressure must be regulated with a nicety which is hardly possible unless the operator has the eyeball under his sole management. The best position for the patient, therefore, is to lie upon a high couch, with his head alone slightly raised. The Surgeon, standing or sitting behind him, can then control the movements both of the upper lid and of the eyeball. Formerly the patient was always seated on a chair, the Surgeon sitting opposite to him, while an assistant steadied the patient's head, and raised the upper lid. But in this way it was impossible for the patient's head to be fixed as immovably as if it were resting on a couch; nor could an assistant, however careful, regulate the pressure he made on the eyeball in exact accordance with that exerted upon it by the operator.

The chief difficulty attending the formation of a proper section through the cornea arises from the fact that the knife has to be carried across a chamber filled with a fluid, ready to escape at the smallest opening which the blade of the instrument may leave unguarded; while the instant such an escape takes place, the elasticity of the contents of the eyeball forces the iris forwards over the edge of the instrument. The sawing motion we employ in using a scalpel, or any other kind of surgical knife, would be inadmissible in making a section of the cornea, inasmuch as each to-and-fro movement of the blade would allow of a fresh escape of aqueous humour, or would inflict a wound on the iris, when that structure had come forward to fill up the place of the lost fluid. Hence arose the necessity for a blade regularly increasing in width and thickness from the point to the heel. Such an instrument, if steadily carried on in one direction, without any rotation, completes the wound at a single thrust, while its wedge-like form prevents the premature escape of the aqueous humour, and so lessens the danger of wounding the iris.

It would be very unprofitable to enter into a description of the various cataract-knives which at different times have been invented.

One operator after another has endeavoured, by alterations in the shape of the blade, to overcome the special difficulty which has most beset him; but Surgeons are now pretty generally agreed that the instrument which goes by the name of Beer's* knife is, with certain modifications, the most useful, and that no merely mechanical contrivance can obviate all the difficulties attending the operation of extraction.

At the time when Beer wrote, and, indeed, long afterwards, the flap was always made at the lower part of the cornea; but the upper section has been found to possess such advantages, that the lower one has completely fallen into disuse.

The patient being placed in the manner described, the Surgeon standing or sitting behind him, raises the upper lid, placing his fingers against the very edge of the tarsus, so as to prevent eversion. An assistant draws the lower lid downwards, and keeps it fixed by making pressure against the malar bone. He must take especial care to do this, and not in the slightest degree to press upon the eyeball. The Surgeon may control its movements by allowing the tip of one finger lightly to touch the sclerotic just above the cornea, while the other rests, as lightly, against the inner edge of the globe. To do this safely requires the greatest tact and care; for, as soon as the knife has transfixed both sides of the cornea, all pressure must cease, and it ought at no time to be greater than will just suffice to enable the Surgeon to make his puncture and counter-puncture with certainty. Firm pressure, kept up till the section is completed, will almost inevitably cause the lens to be violently ejected, with a gush of vitreous humour.

The point of the knife is to be introduced on the equator of the cornea, a short distance in front of its junction with the sclerotic, carried steadily across the anterior chamber, and brought out at the corresponding spot near the inner margin of the cornea. During this thrust the edge is directed towards the upper margin of the cornea, so that, when the section is completed, a semi-lunar flap results.

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* It seems that both Casamata and Barth had employed a knife of the same shape as Beer's, but larger. Casamata's knife, if correctly figured by Wenzel (*Manuel de l'Oculiste*, 1808), resembled Beer's in shape, although there might be some slight difference of size. Beer insists, with amusing earnestness, upon the absolute necessity of the knife being made precisely according to his pattern,—so many lines long and so many broad; if people pretend to operate in his way, and yet deviate from the exact pattern he has laid before them, he will not hold himself responsible for the consequences. (*Lehre von den Augenkrankheiten*, 1817, vol. ii. p. xlvi.)

The Surgeon must take care to give the knife a steady onward pressure, so that the blade may constantly fill up the wound it is making. If he in the least withdraws the knife or rotates it, or if he attempts too soon to cut out, instead of thrusting straight on, a jet of aqueous humour takes place at that portion of the wound which is no longer filled by the blade, and then the iris instantly folds over the edge,—one of the most troublesome occurrences that can attend the operation. The utmost care, however, will not always avail to prevent the loss of aqueous humour; for so ready is the fluid to spirt out, that, if the sides of the knife be unevenly ground, sufficient space may exist between the blade and the edges of the wound to allow of the escape.

If the iris has fairly come over the edge of the knife, the Surgeon may disengage it by drawing the point of one finger over the cornea, from below upwards, and then making a little pressure directly backwards. In this way the iris may be made to slip back behind the edge, and by keeping up careful pressure until the section is nearly completed, the iris may be prevented from coming forward again. It is not possible precisely to describe this manœuvre for disengaging the iris; the pressure employed should be extremely delicate and guarded, and should be wholly taken off before the very last portion of cornea is divided.

The operator may find it impossible wholly to disengage the iris from the knife, and a portion of the upper margin of the pupil may be cut away. This of course causes a slight bleeding into the anterior chamber, which obscures a view of the parts during the next stage of the operation, but the lens usually escapes readily through the artificially enlarged pupil, and, except the deformity, no permanent bad result necessarily follows the accident. Sometimes, however, it happens that a *fold* of the iris is cut through, so that there results a hole in the iris just above the true pupil. When this occurs, the Surgeon must at once divide the strip of iris between the two apertures, so as to lay them into one before he proceeds to lacerate the capsule.

As soon as the corneal flap has been completed, the upper lid is allowed gently to fall, care being taken that it does not catch against the edge of the flap and evert it; and the Surgeon proceeds to the second stage of the operation—the division of the anterior capsule.

After a short pause, he again carefully raises the upper lid, without making pressure on the globe, and surveys the wound. If he has made it too small, he must at once enlarge it, by passing a short, narrow, blunt-ended knife, or the blade of scissors, under the flap, to the outer angle of the wound, and carefully dividing the cornea close along its margin, in a downward direction.

This enlargement of the original wound is always very difficult, on account of the unresisting state of the loose flap of cornea, and the irritability of the eye, which the Surgeon dares not then control by pressure, for fear of prematurely displacing the lens. An able assistant, who can be trusted not to press upon the globe, may often render good service in this difficulty, by nipping up in a forceps a fold of conjunctiva, just below the cornea. Scissors curved on the edges will usually be found preferable to the knife for enlarging the wound. No difficulty should deter the Surgeon from making the wound sufficiently large before attempting to press out the lens; for if, while the opening in the cornea is too small, pressure be made on the globe, the hyaloid membrane will probably give way, and allow a portion of the vitreous humour to escape; and immediately the lens, instead of presenting itself at the section, sinks down into the space left by the lost humour.

When this occurs, the Surgeon must at once desist from all pressure on the globe, and pass in a fine sharp hook through the now gaping wound, and through the pupil, to the hinder surface of the lens, which must be drawn out as quickly and as lightly as possible. Sometimes it is better to pass in the scoop instead of the hook; but, whichever instrument is employed, it must be placed *behind* the lens, which is to be kept pressed against the cornea, otherwise it will be driven still deeper into the vitreous humour.

If the Surgeon has satisfied himself that the corneal wound is sufficiently large to allow of the easy exit of the lens,—and for this purpose it ought to involve nearly half the circumference of the cornea,—he next proceeds to lacerate the anterior capsule. The curved needle* is slipped under the corneal flap, care being taken not to entangle the point in the iris; and when its curve is fairly in the pupil, the handle is rotated so as to bring its point against the capsule. Some writers give very precise rules as to the manner in which the capsule is to be divided. One recommends a crucial incision; another tells us to make a series of cuts crossing each other at right angles, so that the lines of incision may include a number of lozenge-shaped interspaces,—a figure, one would think, rather difficult to execute within the area of the pupil, even in a motionless dead eye, and certainly not practicable upon the irritable eye of a patient under operation.

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* By a curious misnomer, this needle is commonly termed in England the "curette." The mistake arose from an accidental circumstance. The instrument for lacerating the capsule was originally called by the French *cystitome;* the scoop, attributed to Daviel, was called *curette*. It was found convenient to mount these two instruments on the opposite ends of the same handle; and our countrymen, forgetting the meaning of *curette*, have applied that name to the sharp cystitome instead of to the scoop. It is time that we called the things by their right names; for foreigners, in reading reports of English cases, must often be sorely puzzled to understand how we lacerate a capsule, or transfix a lens, with a *curette!*

In tearing through the capsule, the Surgeon should take care that the rents extend quite across the area of the pupil; and if he effects laceration to this extent, he need not trouble himself about lines of incision depicted on diagrams. The laceration of the capsule requires a careful eye and a light hand, otherwise the lens itself may be displaced, the capsule remaining unbroken.

The needle having been withdrawn, with due care against entangling it in the iris, the Surgeon proceeds to the last act of the operation—the removal of the lens.

It is a fatal error to suppose that this removal is to be effected by main force; that the eye may be squeezed in any direction, if only it is squeezed hard enough. The real object of pressure is to make the lens first turn on its transverse axis, so that its upper edge may become tilted a little forwards. To effect this, the concavity of the scoop is laid against the lower lid—which the assistant is not to touch during this stage of the operation—and gentle pressure is to be applied through the lid against the sclerotic, a little beneath the lower margin of the cornea. With the forefinger of the hand which holds the upper lid, similar gentle pressure is made on the upper part of the globe, just above the section; and then, by a carefully regulated alternating pressure on these two points, the lens is made slowly to turn and present its upper edge at the pupil. Coming in contact with the cornea, the edge of the lens is guided upwards, and begins to protrude at the corneal wound. It is evident that as soon as the widest part of the lens has passed through the pupil, the rest will be inclined rapidly to follow; and therefore, if the Surgeon does not moderate his pressure, the lens will suddenly start forward, and will very probably be followed by a gush of vitreous humour. According to the size of the corneal wound, and the degree of superficial softening the cataract has undergone, will be the amount of soft matter the lens will leave behind in passing out of the eye. A small lens will perhaps escape entire through a large wound; while if the wound be small, and the lens bulky and much softened on its surface, a considerable quantity of lens-matter will remain in the pupil and about the lips of the wound.

Quick union of the corneal wound, upon which so much of the success of the operation depends, cannot take place if any foreign matter be allowed to remain between its edges; all soft lens-matter, therefore, which may be sticking there, must be carefully removed with the scoop. The iris, which very frequently protrudes, can be best returned to its position by means of the small spatula. It is unwise to dip again and again into the pupil with the scoop for the purpose of removing every portion of soft lens-matter. The capsule cannot be removed by such means; and it is to this that the fragments very often adhere, and a too free use of the scoop is very likely to rupture the hyaloid membrane, and cause a gush of vitreous humour.

Provided the lips of the wound are in perfect apposition, and the iris in its proper place—which may be known by the central position of the pupil—the capsule, and any small portions of entangled lens-matter, may safely be left for future removal, after the wound is healed and all irritation passed away.

When a gush of vitreous humour takes place at the moment the lens passes out, the Surgeon must immediately close down the upper lid, lifting it over the wound by the eyelashes, so as to prevent the edge of the tarsus catching against the projecting flap of cornea. Any prolonged examination of the wound can only lead to fresh escape of vitreous humour. After a slight pause, the Surgeon, again grasping the lashes of the upper lid, may gently raise it just sufficiently to assure himself that the flap is not doubled down, as frequently happens. Having ascertained that this displacement has not occurred, he must be satisfied, and not wait in the expectation of seeing the wound close; for the constant tendency of the vitreous humour to escape will render any adjustment of the flap impossible. The lids must at once be closed with strips of plaster or a bandage.

Although cases in which a small quantity of vitreous humour has been lost may ultimately do well, a deformity of the pupil always remains. It is large and drawn up towards the wound, and the iris forming the upper margin of the pupil retracts, so as to disappear altogether.

In the foregoing description of the operation by extraction, I have noticed some of the accidents that are liable to occur; but there remains to be noticed one more dangerous than all others, namely, *hæmorrhage into the vitreous chamber.*

Although the corneal section may have been perfectly well made, and every due precaution taken, it sometimes happens that a gush of vitreous humour, usually of watery consistence, occurs at the moment the lens escapes through the wound. Within a few seconds, or at the end of a minute or two, the patient complains of severe pain in the eye, and blood appears oozing from between the lids. This oozing does not take place until the whole cavity of the eyeball has become filled with blood. In some instances, the hæmorrhage sets in several hours after the operation. Some diseased condition of the deep-seated tissues must exist in all these cases—a change of structure in the vessels of the choroid, with or without serous effusion between it and the retina. I need hardly say that, in all these instances of hæmorrhage, sight is utterly lost.

A similar hæmorrhage sometimes follows the removal of staphylomatous projections of the globe. As soon as the prominent portion of the staphyloma has been cut off, the pent-up aqueous fluid and serum, and the diffluent vitreous humour, gush out at the wound; and this sudden removal of support from the enlarged choroidal vessels causes them to give way. In such cases, I have found the whole retina enveloping the large clot which had been forced out of the eyeball; a proof that the blood which had detached the retina must have had its source behind that structure, namely, from the vessels of the choroid.*

AFTER-TREATMENT OF CASES OF EXTRACTION.

The prevalent belief that all operations for cataract are likely to be followed by "inflammation," and that the great aim of the Surgeon is to keep this down, is of course unqualified in the popular mind by any definite notion as to the nature of this "inflammation," why it arises, or what parts of the eye it involves; and many members of the profession, when commencing the study of eye-diseases, have equally vague conceptions of the subject. Let us, then, examine a little into what takes place in an eye after extraction of cataract. We will assume that the structure of the organ, with the exception of the lens, had been in a healthy condition, and that the operation has been skilfully performed.

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* I published two cases of this kind in the *Lancet*, 1845, p. 62?.

The cornea has been divided, by a clean cut, to the extent of half its circumference; the aqueous fluid has escaped; the lens has been gently squeezed through the pupil; the iris is in contact with the hinder surface of the cornea, the cut edges of which are in exact apposition; the concave surface of the upper lid lies against the wound, and affords it support.

Within a few hours,—provided the nutrition of the patient's body is in a healthy state,—adhesion takes place between the cut edges of the cornea. As this adhesion becomes firm, the aqueous humour is retained; it once more fills the anterior chamber, and defends the iris from being pressed against the cornea. The slight irritation to which the iris had been subjected, by the passage of the lens through the pupil, passes off, and within a period longer or shorter, according to the constitution of the patient, the extra quantity of blood, which had been affording reparative material to unite the wound, ceases to be sent thither, and the cure is completed.

This is just what happens in accidental wounds of the cornea. If the patient be at the time in a good state of health,—the wound a clean cut, unattended with contusion,—with no iris or other substance interposed between its edges,—and if the eye be carefully kept at rest, and defended from the action of light and other irritants,—a few days suffice to heal the wound. But let a similar injury be inflicted on the eye of a person feeble from age,—or of one reduced to feebleness by want,—or of one alternately excited and depressed by intemperance,—and suppose the first two patients to be bled and restricted to low diet, while the third continues his indulgence in alcohol,—what will *then* be the result? Non-union of the wound; partial or total slough of the cornea; and morbid changes in the iris and adjacent tissues; finally, loss of the eye, as far as sight is concerned.

And now let us apply these facts to a case of extraction. If the operation has been properly conducted, and all has gone well, in the manner already described, healing of the wound is the natural result. No more blood will be sent to it than the healing-process requires; and as soon as the process is completed, the extra supply will cease.

On the other hand, if the iris has been forced into the wound, a mechanical obstacle to quick union is thereby established, and union must take place by a slower process, effused lymph agglutinating the iris to the cut edges of the cornea, and then gradually drawing them together. If vitreous humour has escaped through the wound, its edges will be kept asunder for some time, but will eventually unite by adhesion.

If quick union is prevented by these or any other causes, what good can *bleeding* do? Will it dislodge the iris from between the lips of the wound? or, when the hyaloid membrane has been ruptured, will it prevent the vitreous body from protruding where it meets with the least resistance? As reasonably might we expect by bleeding to dislodge a piece of muscle that was preventing union by lying between the two ends of a fractured bone.

The pain which not unfrequently sets in a few hours after an extraction is commonly of a neuralgic kind. The patient's nervous system has been excited by anxiety about the operation itself, or its result. Bleeding is sure to increase this neuralgia; while a due supply of digestible food, a small quantity of stimulus, or a narcotic, will at once arrest the neuralgia and prevent its recurrence. And yet, only thirty years ago, such doctrines as the following were taught *ex cathedrâ*, and are still accepted and followed by many in this country, and by a far greater number of Surgeons on the Continent:—that within a few hours after the operation of extraction a quantity of blood should *always* be abstracted, *whether pain come on or not;*—that "from four to eight hours after the operation, unless pain has come on sooner, blood is again to be drawn from a large orifice,"—and yet again, "if pain should come on afterwards, or continue." For the first five days after the operation,—while the patient is being drained of blood in this manner,—his diet is to consist of "nothing but gruel, tea, arrowroot, and panada."*

Extraction of cataract is an operation performed on those who are past the middle period of life, and one naturally expects to find among them many of those conditions of feebleness and impaired function which are incident to old age. No doubt cases occur of an opposite kind, in which the patients are plethoric, over-fed, over-stimulated with alcohol. They require to be "toned down," and their circulation brought into a more healthy state. But then this should be done by regulating their plan of living for several months *before* the operation is performed; not by bleeding them just *after*, and thus placing them in a new and unnatural condition at a period so critical.

The profession is chiefly indebted to the late Frederick Tyrrell for the introduction of a more rational and simple method of treating patients after extraction and other operations on the eye; although he did not so completely abandon bleeding as I am convinced he would have done had he been spared to acquire firmer faith in the *vis medicatrix naturæ.*[*]

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* Guthrie, *Lectures on the Operative Surgery of the Eye*, 2d edition, 1827, p. 347.

As soon as an operation of extraction has been completed, and the Surgeon has satisfied himself that the flap is in a proper position, he should at once close the eye, without permitting any such trials of the patient's sight as may safely be made after the removal of opaque capsule, or the formation of an artificial pupil. Such trials, immediately after extraction, are more likely to disappoint than to satisfy the patient; for when the media of the eye have just been disturbed, and the pupil is still encumbered with shreds of capsule, and perhaps fragments of lens also, objects must necessarily appear to the patient distorted and confused; whilst the opening and shutting of the lids is liable to displace the corneal flap. An assurance from the Surgeon that all has gone well, and that, to restore good sight, time and patience only are needed, will effect much more towards tranquillising the patient than any premature experiments.

Both eyes are to be covered with pieces of folded linen, which are kept in place by a light bandage passing around the head. Some Surgeons prefer applying strips of plaster across the lids, instead of a bandage; but I prefer the latter, as it effectually excludes light, and therefore does away with the necessity for darkening the room, while it affords to the patient a sense of security and protection.

For some hours after the operation the patient should remain on the couch, comfortably supported with pillows. When in bed the best position is on the back; but this is by no means to be insisted on if it becomes irksome, or makes the patient wakeful. That position is the best which is the most comfortable, and likely to induce sleep.

A narcotic is sometimes needed on the first night; and in some persons, especially those accustomed to opiates, it may require to be repeated for several nights in succession; but such cases form the exception, not the rule. Loss of appetite is so apt to follow the use of these drugs, that they should never be given without manifest necessity. I always prefer tincture of hyoscyamus to opium, as being far less likely to cause discomfort the next day or to confine the bowels.

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[*] For much valuable information on this subject consult the 2d volume of his *Practical Work*, &c.

The patient is of course to be thoroughly waited upon, so as to be spared every unnecessary movement or exertion. Tapes passed round the wrists and attached to the sides of the bedstead are a useful check upon sudden movements of the hands during sleep.

A moderate dose of opening medicine, given a day or two before the operation, will obviate the necessity for teasing the patient with purgatives during the first few days succeeding it. Old and feeble persons, especially those with any heart-disease, are sometimes seriously prostrated by being purged on the second or third day after the operation, just when it is so important that the healing process should be steadily advancing.

As regards diet, patients should not be deterred from taking a nutritious meal a suitable time before the operation; and a moderate quantity of easily digested animal food should be given on each following day. In respect of stimulants, it is impossible to lay down any absolute rule. Those accustomed to take wine, beer, or spirits, must by no means be wholly debarred from them at a time when the nutrient power of the body is called upon to form new material for repairing a breach of surface. In short, the Surgeon's object must be carefully to regulate both food and stimulants according to the patient's previous habits; neither keeping him too high nor too low, but as near as possible up to the ordinary level of healthy vigour.

The daily cleansing of the lids requires caution; the object not being to prevent the eyelashes sticking together, for their agglutination forms the best safeguard against the patient prematurely opening the eye. The lower lid and cheek are to be cleansed with warm water, but the upper lid is on no account to be touched, for under its shelter lies the corneal wound, sudden pressure on which would induce great suffering, and might even cause the slightly formed adhesion of the flap to give way.

The progress of the wound towards healing is to be judged of by the condition of the lid, and the quality of the secretion. If the patient complains only of an occasional pricking, or a sensation of grit; and if this can be traced to the slight involuntary movements of the wound against the lid; if this uneasiness subsides day by day; if the secretion consists of tears alone, or is mixed with a little of the natural conjunctival mucus; and if the skin of the upper eyelid retains its healthy appearance, and is free from redness and swelling,—the Surgeon may entertain the best hopes that a good union is going on.

An increased feeling of grit in the eye, coming on after the lapse of three or four days, and perhaps attended with neuralgia, would lead the Surgeon to suspect that the section had yielded, and that *prolapsus iridis* had occurred.

The most unfavourable sign is a bright redness and a swelling of the upper lid, which sometimes appear on the second or third day after the operation, attended with a yellow puriform discharge. These appearances are commonly ushered in by a restless night, with headache and considerable depression both of body and mind. When the lid is raised, the ocular conjunctiva is found injected, and so œdematous that it overlaps the corneal margin (*chemosis*). The cornea itself is throughout yellow and opaque, so that no trace of iris can be discerned through it; the wound is gaping, and filled with bulging iris. Eventually the whole cornea softens, the flap sloughs, and the eyeball shrinks.

I have now and then seen this hopeless state of things come on after an operation which had been perfectly well performed, and when the Surgeon had every reason to expect a most successful result. In such cases there has probably been some degeneration of tissue in the vessels supplying the globe, and a weak condition of the heart itself.

The time that should be allowed to elapse after the operation, before the eye is examined, may vary according to circumstances. In a healthy patient, when there has been no pain in the eye, or other bad symptom, the wound may be found perfectly united as early as the third day after the operation. But, as a rule, the fourth day is quite soon enough for an examination; and whenever there has been any loss of vitreous humour, so that the healing process has been retarded, the fifth will be the earliest day on which the eye can be prudently exposed. Indeed, in an old or feeble person, a wound which on the fourth day is going on well, will be all the better for another day of rest; and it often happens that a premature exposure sets up irritation, and, if the union be not firm, favours the subsequent yielding of the wound and prolapse of the iris.

If redness of the upper lid, attended with puriform discharge, comes on within the first two or three days, the Surgeon should examine the eye just so far as to obtain a view of the lower part of the cornea, and ascertain whether it is becoming infiltrated with pus; and this may be done without exposing the wound itself.

It would be impossible to detail all the appearances which an eye may present when first examined after the operation; but it may be useful to describe some of the leading points which present themselves, both in favourable and in unfavourable cases.

1. The cornea may be transparent, with the exception of a little hazy line along the edge of the wound; the aqueous humour may have been resecreted, and the plane of the iris vertical; the pupil being either clear and black, or filled with a flocculent mass of capsule and lens-matter, accordingly as the lens has come out clean, through a large wound, or has rubbed off some of its soft cortical substance in passing through a small one. Vision may extend to the recognition of large objects, such as the fingers of a hand; or, in consequence of the obstruction still remaining in the pupil, may be limited to mere perception of direct or reflected light. Some little redness of the sclerotic and conjunctiva will of course be present in every case, an additional supply of blood having been sent to repair the corneal wound.

The appearances above described are most satisfactory, and would encourage the Surgeon to look forward to a successful result.

2. The eye may present all the foregoing appearances, with the exception of the iris being in contact with the hinder surface of the cornea. This absence of anterior chamber arises from one or other of the following causes: either the wound, although sufficiently united to keep the cornea in its proper curve, has not become so consolidated as to be perfectly water-tight, and the aqueous humour therefore escapes as fast as it is formed; or else this fluid, which seems to be chiefly secreted in the posterior aqueous chamber, may be so pent up there by the lens-matter filling the pupil, as to thrust the whole iris forwards against the cornea. In the former case, by keeping the eye closed for two or three days longer, and giving the patient a little more stimulus or tonic, the wound will become consolidated. In the other case, the iris will slowly recede as the lens-matter in the pupil becomes absorbed, but perhaps will not quite resume its vertical position until the capsule at a later period shall have been broken through with a needle.

It occasionally happens that although the corneal wound, when examined on the fourth or fifth day, appears well united, it subsequently gives way a little at some point, and allows a small portion of the iris to protrude, so as to cause slight displacement of the pupil.

3. The eye may be found in the following state: the cornea clear, the section gaping, and blocked up with iris, the latter having

prolapsed into the wound, after being adjusted at the operation, and no union between the two structures having occurred, in consequence of the feeble condition of the patient. In these cases the parts on the fourth day after the operation may appear almost as if the wound had been just inflicted. Chronic inflammation is sure to be set up, and is often attended with neuralgia. In non-union of this kind, it is sometimes good practice to keep the eye uninterruptedly closed for five or six days after the first examination, provided the healthy appearance of the lids, and the absence of puriform secretion, give assurance that the healing process is advancing.

4. Still more unfavourable than the appearances above described are the following:—in addition to a gaping section and prolapsus iridis, a cornea hazy throughout, so that the iris cannot be clearly discerned; the edges of the wound thickened, opaque, and creamy-looking; the sub-conjunctival tissue infiltrated with serum, and the conjunctiva itself reddened and elevated (*chemosis*).

These local changes have usually been ushered in with pain in the eye and head, restlessness, and depression. Extreme care is necessary to treat a patient under such circumstances. Narcotics will probably be required at night; of these hyoscyamus is the best, and bark and ammonia are almost sure to render good service in keeping up the appetite and restoring vigour to the flagging circulation. The diet will require the most careful management, so as to insure a sufficiency of nourishment being taken without oppressing the stomach; above all, the regulation of the supply of stimulants—wine or beer—will demand much judgment on the part of the Surgeon, so that the patient's powers may be raised and sustained, without causing irritability and subsequent depression. But it will sometimes happen, in spite of care and skill, that such cases as these will terminate in closure of the pupil, with wasting and softening of the whole globe.

Although it is so important, after the operation of extraction, to defend the patient from strong light for several days, there is no necessity for closing shutters, and drawing curtains closely round the bed, if the patient's eyes have been bandaged in the manner I have described. Very moderate shading of the room is then sufficient, and thorough ventilation is most beneficial; for due aeration of the patient's blood is essential to the healing process.

Prolapsus iridis. If the corneal section, instead of uniting by adhesion, has undergone that slower process of closure which takes place when a portion of iris is interposed between the edges of the wound, the *prolapsus* continues for some time to be a source of irritation. It should not, however, be too hastily interfered with; for, in healthy subjects, it usually wastes and flattens down by slow degrees. Sometimes, however, instead of diminishing in this manner, it becomes distended into a little vesicle, in consequence of the accumulation of aqueous humour behind it. If the prolapsus fills up nearly the whole extent of the wound, the corneal flap may be tilted forward in such a manner as to form an obtuse angle with the lower portion, the base of the flap being marked by a transverse crease, extending quite across the cornea from one angle of the wound to the other. As the process of contraction in the prolapsed iris goes on, the edges of the corneal wound are gradually drawn together, the transverse crease disappears, and the natural curve of the cornea is eventually restored.

If, however, instead of diminishing, the prolapsus remains as a large and prominent vesicular projection several weeks after the operation, means must be taken to induce it to contract. In many cases it is sufficient to puncture it with a broad needle, and, when the aqueous humour distending it has escaped, to touch the collapsed iris very lightly with a point of nitrate of silver. The eye must then be kept closed for a day or two. Should the prominence reappear, the application of the nitrate of silver may require to be repeated; but it must never be used except with a light hand, a single touch being sufficient to whiten the surface.

Fistulous wound. If a case be not well watched for several months after the operation of extraction, the wound may become fistulous. This is an extremely rare occurrence; so rare, indeed, as to be unnoticed by most of the authors on ophthalmic surgery. On this account, I will relate two cases which occurred under my own observation. In the first case, I could not quite satisfy myself as to whether the fistula resulted wholly from defective repair of the original wound made in extraction, or whether it was the consequence of a puncture I made in a very troublesome vesicular prolapsus.

In the second case, the prolapsed iris gave way spontaneously, many months after extraction, when the cure might be considered complete.

1. Captain G., aged 76, was operated on by extraction in the right eye, Nov. 18, 1854. Nothing untoward occurred during the operation, and although a small portion of iris subsequently prolapsed into the wound, there was every reason to expect that its contraction and solidification would take place in the usual manner. By the end of the month, however, the prolapsus, instead of flat-

tening down, became distended at one spot into a little vesicle. Meantime the pupil had of course become somewhat drawn upwards, and it was also obscured by a hazy condition of the flap; the lower half of the cornea always retaining its perfect transparency. On the 19th of January 1855, the vesicle still existed, and the anterior chamber had never been restored since the operation, the iris lying in contact with the cornea. It appeared to me, therefore, that at some part of the cicatrix a minute aperture must exist which allowed the aqueous humour slowly to exude. I punctured the vesicle with a cutting-needle, and touched the collapsed surface with a fine point of nitrate of silver. Three days later, I again touched it in the same manner. After a time the vesicle again became prominent; and on Feb. 1st, by the aid of a lens, I distinctly recognised the existence of a fistulous opening at its summit. The aperture was as minute as the section of a human hair, but pressure on the globe caused an escape of aqueous fluid to be distinctly perceived. I now coated a fine hair-like probe with a thin film of nitrate of silver, passed it quite into the minute fistulous track, and then kept the eye closed for several days. Meantime the patient's diet and allowance of stimulants, which had been liberal from the first, were increased. March 12th, the vesicle had flattened down, but slight oozing from the fistula still continued. Nitrate of silver on the fine probe was twice repeated, at an interval of some days. By the end of May, the cicatrix of the wound was quite flat, but a very slight oozing of aqueous humour still continued; so slight indeed, that some little accumulation took place in the anterior chamber, so that the iris and cornea, although very close together, were not in actual contact.

It was now evident that it would eventually be necessary to draw the pupil downwards, from behind the hazy portion of cornea adjoining the cicatrix, and so bring it opposite the clear portion below. But of what avail would this be, unless the fistula could be closed? It appeared to me, that by at once performing this displacement of the pupil, a double object might be attained, and that the wound made at the lower part of the cornea would for a time effectually drain off the aqueous humour, diverting it altogether from the fistula, which would thus be placed in a condition favourable to closure. Accordingly, on May 30th I made an opening at the lower edge of the cornea with a broad needle; caught the lower edge of the pupil with a blunt hook, and drew out and cut off a very small portion of iris. An excellent pupil resulted. Ten days after the operation, I was much pleased to find the fistula closed and the aqueous humour completely retained, and this after a lapse of more than six months from the performance of extraction. Two years later, the patient was enjoying excellent vision both for far and near objects, reading the editorial articles in the *Times* with a glass of two inches and a half focus.

In the foregoing case I was induced, by special considerations, to perform extraction at a very late period of the year; and the winter, which soon afterwards set in, was unusually cold and protracted. It will long be remembered as the terribly severe winter of the Crimean campaign. No doubt the low temperature contributed to lessen the reparative power of so old a person; and the long continuance of frost and cutting winds, which kept him confined to the house till May, deprived him of the invigorating influence of exposure to the open air.

2. An elderly woman, from whose left eye I had extracted a cataract in 1857, came to me two years afterwards, complaining that the sight of this eye, which had been very good ever since the operation, had within a few weeks begun to fail. On carefully examining the eye, I observed that near the middle of the cicatrix, which was rather broad in consequence of some slight prolapsus iridis having followed the operation, there was a minute fistula, through which the aqueous humour was slowly oozing. The anterior chamber was nearly full, and the plane of the iris almost vertical, the escape through the very minute aperture being counterbalanced by the secretion of fresh fluid. The fistula was so minute that it might easily have escaped notice, and it was only by absorbing the moisture adjacent to it with a bit of blotting-paper, and protecting it from the trickling-down of the tears, that the welling-up of the aqueous humour could be positively demonstrated. I had no doubt that this fistula was of very recent formation, for otherwise the patient would not have enjoyed such good sight as had existed until within a few weeks of her coming to me. Probably the cicatrix had always been thin and tense, and now from some accidental cause it had given way at the weakest point.

At first I tried the effect of touching the fistulous orifice with a fine probe coated with nitrate of silver. This was done twice, and for a few days after the second application it appeared to have been successful; but again the little channel opened itself. I then made a counter-puncture with a broad needle at the lower part of the cornea, and let out the aqueous humour, having just before again introduced the fine probe coated with nitrate of silver into the fistulous orifice. The lids were kept in contact with strips of plaster. A week later the fistula was completely closed, and sight was improving.*

These fistulæ of the cornea are likely to be overlooked, on account of their extreme minuteness; for their aperture is sometimes no larger than the section of a human hair, and the quantity of fluid oozing out is small in proportion. The fistula of course allows a constant escape of aqueous humour, and the anterior chamber becomes obliterated, the iris lying in contact with the cornea. This drain of aqueous humour, if unchecked, seems to exert some peculiarly exhausting influence upon the eye, for in all the cases I have seen in which fistulæ of the cornea had existed for several years, all useful vision had become extinct.

There are certain points connected with the operation of extraction which may seem to have required notice before the operation itself was described; but it appeared preferable to reserve them for later consideration, because they can be properly appreciated by those only who have already made themselves acquainted with the details of the operation.

Inasmuch as extraction is performed upon persons more or less aged, it must often happen that the constitution of such patients has been damaged by various forms of acute or chronic disease before they come under our care as the subjects of cataract; so that we cannot expect to find them by any means in as favourable a condition for undergoing an operation as those whom we are in the habit of treating for many other surgical affections. There are, however, certain conditions which would either wholly contra-indicate extraction of cataract, or would cause us to undertake the operation only after the most careful preliminary examination, and unusual precautions against the more pressing difficulties of the case.

1. Extensive heart-disease is of all complications the most unfavourable; for, by enfeebling tho supply of blood to the peripheral tissues of the body, it lessens the probability of a quick union of the corneal wound.

2. Violent cough, if occurring in suffocative paroxysms, would also greatly imperil the success of the operation; partly by the unavoidable restlessness and frequent change of posture, and partly by the straining and shaking of the eye, which may disturb the wound, and induce prolapsus of the iris.

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* This case was reported in the *Medical Times and Gazette* for Aug. 27th. 1859.

3. Fat and flabby persons have much less reparative power than those who are thin. Dry and wrinkled, but still vigorous old people,—such as are popularly termed "wiry,"—are of all others the best adapted to undergo extraction.

4. Certain morbid conditions tend to render the operation in various ways difficult, although they by no means forbid its performance. Total deafness, and deaf-dumbness, for instance, in a great measure remove the patient from control; but I have successfully operated on patients under both these disadvantages.

5. Mere old age does not contraindicate extraction; for one occasionally meets with persons of advanced years whose bodily functions are performed with surprising regularity.* Commonly, however, the reparative power of the cornea is impaired after seventy.

6. If cataract is equally advanced in both eyes, and both appear equally well suited for operation, ought we to extract both lenses at one sitting? On this question much difference of opinion exists. My own judgment is decidedly in favour of operating on one eye only at a time. We learn much by watching the progress of a case after operation, and often see how, by this or that precaution, or course of treatment, a difficulty or a bad result might have been avoided. We operate, for instance, on a depressible patient during very hot weather, and find him utterly overcome and prostrated by it, perhaps to such an extent as to induce non-union of the wound, or even partial slough of the cornea. Were this to occur after we had operated on one eye only, we should learn experience by the result, and take care to select a cooler season of the year for operating on the other eye.

Or our patient may have deceived us as to his previous habits. He may for years have been accustomed to take large quantities of stimulants, and our first operation may have failed because we had not kept up his reparative powers sufficiently by artificial aids. Having learned the truth, too late to save the first eye, we might be able, by adopting a different plan of after-treatment, to save the second.

Without unnecessarily multiplying illustrations, I may say that by operating on one eye at a time we secure to ourselves the advantage of making our first operation a means of invaluable in-struction with respect to the second; while, at the same time, the effort of nature in repairing a single corneal wound is of course less than is required for the repair of a second wound of equal extent.

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* Such was the case with a gentleman of eighty-six, upon whom I operated by extraction. I could really detect in him no organic defect whatever, and he is at present (1861), four years after the operation, in the enjoyment of excellent health and good sight.

7. Ought we to operate when cataract is fully formed in one eye, while the other is either free from cataract, or only slightly impaired by its existing at an early stage?

Exceptional circumstances may make it desirable in such a case to operate on the cataractous eye; but in the great majority of cases it will be proper to wait until cataract is fully established in the other. Of course, after the extraction of the crystalline lens, a convex glass becomes necessary, to compensate for that portion of the optical apparatus of the organ which has been taken away; and it is almost, if not quite, impossible so to adjust any mechanical aids as to make the operated and the unoperated eye work well together. Each eye, taken separately, may be good; but there is a want of harmony between them which can never be reconciled.

8. The last question to be considered is, whether any particular time of the year is to be preferred for the performance of extraction? As far as the mere operation itself is concerned, I know of no period being positively contraindicated, except the extremes of hot and cold weather. Severe cold acts unfavourably on old people by retarding the circulation of blood in their capillaries; while extreme heat enfeebles the action of the heart, especially when it happens—as is so common in old age—that some organic change has already taken place in it. The only time which I systematically avoid for performing extraction is during that sultry weather which sometimes visits us in July and August.

But one has to consider not merely the operation itself; the period of complete repair and convalescence is equally important. It is of the utmost consequence that a patient who has gone through the confinement and the mental anxiety inseparable from so important an operation as that for cataract, should at the earliest possible period enjoy the invigorating influence of change of air; and nothing tends so much to prolong that condition of chronic ophthalmia, which sometimes follows extraction, as too long a confinement to the sick-room. A few days of careful exposure to the fresh air during genial weather equally improves the eye and the patient's general health. It is, therefore, of importance so to time the operation that the period of convalescence may coincide with the finer season of the year; and this can only be done by choosing the spring and early summer for the operation. April, May, and June are, therefore, the best months to select for extraction, although the later summer months may be chosen, provided the weather be not sultry and oppressive.

OPERATIONS ON OPAQUE CAPSULE.

I have elsewhere alluded to the statements of Stellwag and others respecting the so-called opacities of the capsule (p. 795). Surgically speaking, it matters not whether the capsule, which remains in the pupil after various forms of cataract operations, be in its very substance opaque, or whether it be only coated with opaque material. It obstructs vision, and must be removed.

After the lens has been got rid of by solution, the anterior and posterior portions of the capsule which have been broken through at the centre, retract, and form a white ring, which is often wholly concealed when the iris is in its natural condition, only becoming visible when the pupil has been artificially dilated. Sometimes a band or two may stretch across the pupillary area.

After extraction also, it commonly happens that the shreds of torn capsule form a delicate film, blocking up the pupil; and if any slight degree of iritis has followed the operation, this film may be made additionally dense and visible by exudation of lymph. Even when the area of the pupil looks black and clear, some months after extraction, the Surgeon should endeavour to keep the patient in view; for perhaps at the end of a year or so a filmy membrane will be found stretching across the pupil, so delicate as to be detected only after the closest scrutiny, and with the aid of concentrated light; and yet the existence of this film will just prevent the patient being able to read. Short of this point, he may see all objects well, and yet, for want of tact and care in detecting this slight obstruction to vision, the Surgeon may lose the credit and the satisfaction of having performed a first-rate operation.

In some instances, the film, which forms many months after extraction, appears to be produced by an opacity of the hyaloid membrane advancing towards the plane of the pupil after the lens and its capsule have been removed.

There are no manipulations which demand more judgment and care than those for removing capsular obstructions. The two chief points to be observed are: to make the aperture in the capsule central, so that it may correspond to the axis of vision; and to avoid isolating any portions, by completely detaching them from the rest of the membrane. Loose shreds, when set floating by unskilful management, are ever afterwards a source of annoyance to the patient. Above all, the division of the capsule is to be made with the least possible disturbance of the vitreous body.

Every movement of the needle should have a definite object. It is useless to make random stabs and plunges at detached portions of capsule, in the hope of depressing them by some lucky hit; for their buoyancy will almost always cause them to return to their former position as soon as the needle is withdrawn. Delicate bands, tightly stretched across the pupil, may be divided in the middle, and then each half will retract towards its fixed point, and leave the interval free.

When a single needle is employed to tear through a portion of capsule, it sometimes happens that the delicate membrane yields and stretches, instead of being torn, and, after each attempt, the Surgeon is mortified at seeing it return to its former position. It is in such cases that it is so efficacious to use two needles at once, as suggested by Mr. Bowman.* There is hardly any filmy expansion, or hair-like band, that may not by this means be divided.

The lids being held apart with a spring speculum, the Surgeon has both hands at liberty, and he separately introduces the needles through the cornea, until their points reach the area of the pupil. He then, according to the nature of the obstruction, either makes in the centre of the opaque membrane a small hole, and then enlarges it by drawing the points of the needles in opposite directions, or cuts, twists, or tears through some band or filament which had been holding together the margins of the pupil.

If the rules which I have said (pp. 818, 9) should guide the Surgeon in effecting the absorption of a cataract be strictly adhered to, namely, to attack the lens at the centre, always working the needle steadily from that point towards the circumference, and to be satisfied with slow progress, without attempting to break up a large mass of lens at the earlier operations; and if he carefully avoids isolating and setting loose any portions of capsule,—he will rarely find it necessary to employ any other instruments than needles for obtaining a perfectly clear pupil.

But if a case has already been unskilfully operated on, and the needle used roughly and without any settled aim, it may happen that the entire capsule containing some small remains of white lens-matter has become crumpled up and rolled into an opaque mass, which is either moored in the midst of the pupil by two or three delicate bands, or is attached by a single filament, which allows the mass of capsule to float and sway to and fro with every movement of the eye. In such a case the entire mass of capsule must be extracted.

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* *Medico-Chirurgical Transactions*, 1853, vol. xxxvi. p. 315.

To effect this, an incision of suitable size is to be made through the cornea near its edge, and a forceps introduced, the points being kept closed until they have reached the capsule. This is then seized, and withdrawn by gentle traction, sufficient to make the retaining filaments give way.

The forceps used for this purpose must be so constructed that, when its points are separated, the iris will not fall between them. The cannula-forceps best fulfils this indication.

EXTRACTION THROUGH THE SCLEROTIC.

I allude to this operation simply because it is mentioned in works on ophthalmic surgery. Those who first suggested it were misled by the apparent advantages of making a wound which would avoid any interference with either the cornea or the iris; but they overlooked the far more serious injury the eye must sustain from a large incision in the sclerotic and choroid, extensive loss of vitreous humour, and the introduction of instruments for seizing and dragging out the lens. The history of the operation is little more than a history of destroyed eyes; and those who wish to satisfy themselves on this point may refer to the cases quoted by Mackenzie in his *Practical Treatise* (4th edition, 1854, p. 812).

"LINEAR EXTRACTION."[*]

The operation of breaking-up soft cataracts with a needle, and subsequently evacuating the pulpy mass through a small incision in the cornea, was first suggested and put in practice by Gibson.[†] Travers[‡] modified the operation without apparently improving it. His proceeding differed from that which has lately been adopted by

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[*] This term is not well chosen, for it fails accurately to convey the intended meaning, namely, that the corneal wound is made in a *straight* line, in contradistinction to the *crescentic* wound made in ordinary extraction. The latter incision also forms a line, although a curved one; and "rectilinear"—as the opposite to "curvilinear"—would be the correct term to use, if we wish to imply that the line of corneal wound is to be straight.

[†] *Practical Observations on the Formation of an Artificial Pupil; . . . . . to which are annexed, Remarks on the Extraction of Soft Cataracts, and those of a Membranous kind, through a Puncture in the Cornea*, London, 1811.

[‡] "Further Observations on the Cataract," *Med.-Chir. Trans.* vol. v. p. 391.

Gräfe* in respect of the size and position of the corneal incision, which Travers directed to be made close to the edge of the cornea, including a fourth of its circumference.

Gibson had advised that the capsule, and the softened cataract itself, should be freely broken up with a needle, and that, after all irritation had subsided,—say in three or four weeks,—a small corneal incision should be made, and the remains of the lens removed with the scoop.

The first modification of Gibson's operation, by Gräfe, chiefly consisted in making the incision in the cornea at a considerable distance—about a line—from its margin, and perfectly straight instead of crescentic. He justly considered the straight corneal wound to possess the great advantage of healing more quickly than a flap-wound, and involving less risk of any iris prolapsing into it; but, on the other hand, a straight corneal wound does not gape, and therefore requires more mechanical interference to aid the passage through it of the pulpy lens-matter.

Having made a vertical incision through the cornea to the extent of two, two and a half, or three lines, according to the consistence of the cataract, Gräfe passes in a cystitome, having a small fleam-shaped head, set at a right angle on the end of a short straight stem; with this he lacerates the capsule and breaks up the softened lens. Having withdrawn the cystitome, he next introduces through the corneal wound a scoop; and, passing its extremity into the midst of the pulpy mass, endeavours, by pressing against the edge of the wound, and so making it gape, to effect the escape of the disintegrated lens-matter along the groove of the instrument.

In his first essay (*Archiv für Ophthalmologie*, 1855), Gräfe laid down the following rules respecting the removal of a cataract by the so-called *linear* extraction. That it was specially indicated in cases of wholly *fluid* cataract, which required a corneal incision only two lines in length; also when the lens was of *pulpy* consistence, in which case the incision would have to be made half a line longer. That the removal of a lens which had retained the normal consistency of the earlier periods of life would require the incision to extend to three lines, and even then could only be got out with much mechanical interference; and he therefore considered the operation unadvisable in such cases, as well as in those of unripe cataract.

In all cases of cataract in which a *hard nucleus* existed, he pronounced the operation to be absolutely contraindicated.

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* *Archiv für Ophthalmologie*, 1855, vol. i. p. 219.

According, however, to a more recent publication,* he appears to have grown much bolder in dispensing with the old operation of extraction, and describes a process for removing through a small corneal wound lenses which, although softened in their cortical portion, still retain a firm nucleus. In this operation the incision is to be quite at the margin of the cornea, and to include a quarter of its circumference. Then, to afford room for subsequent manipulations, a large piece of the iris adjacent to the corneal wound is to be cut out; next, the anterior capsule is to be freely torn up with the cystitome; and, lastly, a spoon-shaped scoop is to be passed through the softened cortical portion to the back part of the nucleus, which is to be kept steadily pressed against the hinder surface of the cornea while being spooned out through the wound.

Those who have been accustomed to practise the old form of extraction, and who know the extreme gentleness and tact that are required throughout every stage of the operation, will be staggered at the unceremonious way in which the Berlin professor removes obstacles, and will be apt to think the iris of too much importance to allow of a large portion of it being cut away, merely to afford room for the passage of the lens. The objection that must strike every practised operator is the risk in passing the scoop behind the nucleus, and in drawing it out through so small a corneal wound. In the first manipulation there must be the very greatest probability of the scoop passing altogether behind the posterior capsule, and so rupturing the hyaloid membrane, and letting out vitreous humour; and, during the attempt to extract the firm nucleus, there must be a risk of its slipping from the scoop; while, at the best, the passing in and out of instruments through the small corneal wound cannot fail to be a source of great and often disastrous irritation.

CHAPTER VIII.

GLAUCOMA.

"GLAUCOMA" is a term which has eventually acquired a meaning quite different from that originally ascribed to it. Among the ancients "glaucoma" signified opacity of the lens, and was therefore regarded by them as a wholly incurable disease, inasmuch as to remove the lens from its position was deemed equivalent to interfering with the seat of sight itself. At a later period the etymology of the word caused it to be applied to many cases of greatly impaired or lost vision, originating in disease of the optic nerve, and combined with fixed dilatation of the pupil. For, in such cases, the change of colour which the lens naturally undergoes in old age, and some slight diminution of its transparency, combined to impart to the light reflected from the fundus of the eye a grayish or drab colour, which, in descriptions, was exaggerated into green; and much labour was expended by ophthalmic writers, not many years ago, in attempts to explain the cause of this so-called green or *glaucous* tint. In fact, the dull grayish reflex, upon which so much stress was formerly laid, may be perceived in the eye of almost any old person, when the pupil has been fully dilated with atropine.

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* *Archiv für Ophthalmologie*, 1859, vol. v. p. 158.

The word "glaucoma" has now come to be used,—without any reference to its etymology, and in a purely arbitrary sense,—to signify a disease gradually involving every tissue of the eyeball, and, if left to itself, ending in total blindness. This loss of sight may ensue as a result of two widely different morbid processes; the changes of structure in the one case going on in a slow and gradual manner; while in the other case, changes, apparently the same, take place as the result of most intense inflammation.

Patients who come before us as the subjects of confirmed glaucoma are almost invariably beyond the middle period of life, commonly between fifty and sixty. They are, for the most part, pale and unhealthy in appearance, often showing that worn expression which becomes impressed on persons who have gone through much suffering.

The eyeball, instead of having the slight degree of elasticity natural to it in health, is remarkably hard, giving to the finger almost the sensation of a stone.

The sclerotic, often marked with faint dusky patches, is traversed by large purple tortuous veins, which emerge abruptly close to the margin of the cornea. Sometimes there is also a slightly marked vascular zone.

The cornea, although it may be sufficiently transparent to allow of the iris being well seen, presents a peculiar unevenness of its epithelial surface; so that the lines of a window-frame, instead of being distinctly depicted on the corneal surface, appear wavy and irregular; and the reflected light is dull, like that from a slightly steamy glass. In some cases the cornea is hazy throughout its substance, and occasionally the epithelium is found vesicated in small patches.

If the state of the cornea allows a good view of the iris, it will usually be found in close approximation to the cornea, the pupil being dilated to its fullest extent; sometimes the pupil is less dilated, but irregular. The change in the appearance of the iris is very characteristic. Its sharply-defined fibrous character is lost, and it assumes a peculiar *slate*-colour. Sometimes the veins of the iris are sufficiently enlarged to be distinctly visible to the naked eye.

The lens advances very near to the cornea, and in cases of old standing is opaque. Sometimes this opacity has a milky appearance, with slight indications of striæ, and the whole lens looks full and swollen, as if it had undergone maceration, and were about to burst its capsule. Occasionally the divisions between the planes of lens-fibres are very distinctly seen. The lens may vary much in colour, appearing grayish or greenish drab, dirty yellow, or dull orange.

Perception of objects is wholly lost; sometimes the retina is even insensible to strong light.

An eye may present all the above-mentioned appearances in consequence of slow disease, advancing, with intervals of quiescence, during months or even years; or, on the other hand, the same appearances may be the result of an acute inflammatory attack, coming on in the most sudden manner, and within a few days producing all the changes above noticed, with the exception of the opacity of the lens, which takes place more slowly.

Mere inspection of an eye in which glaucoma is complete will not enable the Surgeon to decide whether the morbid changes have been the result of the *chronic* or the *acute* form of the disease.

1. The chronic form begins very insidiously, and is often set down as incipient cataract or amaurosis. The patient complains of dimness of sight, and sometimes, but by no means invariably, sees colours or flashes when in the dark. Dull pain in the eye or head may or may not be present. When pain comes on, a faint vascular zone usually appears in the sclerotic, adjacent to the corneal margin. The iris gradually loses its contractility, and the pupil becomes enlarged, not uniformly, but so as to assume an irregular, instead of a circular form.

Several months may elapse without any marked change of symptoms. An insidious form of chronic iritis may then set in, the veins of the iris becoming visible, and the pupillary margin here and there adhering to the capsule. By this time vision may have been lost, or become restricted to the recognition of large well-lighted objects. Next, opacity of the lens gradually commences, or perhaps the cornea becomes hazy, and its epithelium uneven, and then the advance of cataract is scarcely perceived. By degrees the lens and iris advance towards the cornea; the large purple veins, which had begun to show themselves on the sclerotic at an early stage of the disease, become more developed, and at the end of many months, perhaps even a year or two, from the commencement of the disease, vision becomes wholly extinct.

The sequence of morbid changes in chronic glaucoma, then, seems to be as follows: first, congestion occurs in the retina and choroid, going on perhaps to effusion of serum between these two structures. This effusion causes a bulging forwards of the lens and iris, in consequence of the pressure exerted on the vitreous body. Congestion and inflammation of the iris and cornea next set in; and lastly, the lens becomes opaque in consequence of its deranged nutrition.

2. *Acute glaucoma*, as I have already observed, produces structural changes almost identical with those I have just been describing as the results of the chronic disease. The manner, however, in which these changes are effected in the acute form is very peculiar and striking.

The attack usually commences in the evening, with dull pain in the eye, attended with some mistiness of sight and redness of the conjunctiva and sclerotic. The pain soon becomes acute, and assumes the form of intense neuralgia throughout the ophthalmic division of the fifth nerve, extending even to the second and third divisions. In some cases the attack begins in the night, the patient being awakened by intense pain in the eye and head. Within a day or two, sometimes within a few hours, sight is lost, often so completely that even bright light cannot be perceived.

It not uncommonly happens that the second eye is attacked soon after the first. Only an interval of a day or two may elapse between the two attacks; in other instances, a period of several days; or the second eye may altogether escape.

Within a few hours from the onset of the inflammation, the pupil is found to be irregular in form, dilated, and quite fixed. The slaty discoloration of the iris, which I mentioned as such a distinctive mark of chronic glaucoma, is very rapidly produced in the acute form.

In a patient whom I had the opportunity of closely watching in the hospital, this slate-coloured appearance of the iris was strongly marked on the third day from the commencement of the acute attack. I had admitted him for acute glaucoma in the right eye, of three weeks' duration. The usual inflammatory appearances were present, and vision was so much impaired, that with the affected eye he could barely count fingers, and could not see type on a page. I excised a portion of his iris. On the following day the left eye was attacked just as the right had been, and three days later a considerable portion of the left iris had lost its natural brownish hue, and assumed the characteristic slate-colour. A portion of the left iris was at once excised. Within a fortnight the right iris had completely regained both its natural colour and its fibrous appearance, and a few days later the texture of the left iris also looked healthy.

A day or two from the commencement of the attack, the cornea undergoes a marked change, the brilliancy of its surface being lost, and the epithelium appearing as if minutely granular. The globe is unnaturally hard and stony to the touch, and even slight pressure causes pain.

The subjects of acute glaucoma are usually past the middle period of life, and commonly some chronic derangement of general health, or mental anxiety, has preceded the attack. It happens, however, in exceptional cases, that the inflammation sets in while the patient appears to be enjoying good health.

Causes. The actual primary cause of acute glaucoma is as yet unexplained. A general congestion of the vessels of the globe suddenly sets in and produces the various phenomena I have been describing; but the point to be determined is,—what causes this sudden congestion? To say with Gräfe, that "intraocular pressure" is the cause of the phenomena, does not explain the matter; for we have still to ask, What causes this pressure?

The following is Gräfe's definition of glaucoma (*Archiv für Ophth.* vol. iii. p. 481): "I consider acute glaucoma to be a chorioiditis (or iridochorioiditis), with diffused imbibition of the vitreous body (and aqueous humour), whereby, through increased bulk of the latter,* a rapid increase of intraocular pressure, compression of the retina, and the well-known train of consecutive phenomena are induced." In his later essay he expresses his conviction that the disease of the optic nerve alone is insufficient to embody the idea of glaucoma, and that this can be effected only by considering the phenomena of pressure in their totality. "If," he says, "we are to regard delineations of disease as a basis for practical results, we must not restrict our idea of glaucoma to excavation of the optic nerve, nor to any other single symptom of pressure, such as paralysis of the iris, insensibility of the cornea, &c.; but we must duly group together all the various phenomena." (*Archiv für Ophth.* vol. iv. pp. 143-4, 1858.)

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* With the view of presenting to the reader the author's definition precisely in his own words, I have not only translated the German literally, but have preserved the typographical arrangement of the original. It is evident, however, that the parenthesis enclosing "and aqueous humour" is incorrectly placed, and that "latter" is a slip of the pen for "former," since it is to increased volume of the vitreous body that Gräfe chiefly attributes the intraocular pressure.

In eyes affected with so-called glaucoma, which have been examined after extirpation, a varicose condition of the minute vessels of the retina has been observed with the microscope; and rupture of a number of these diseased vessels, with consequent extravasation of blood, has been suggested as the primary cause of the disease. Such extravasations, however, although they might explain the dimness of sight, would not account for the other phenomena of glaucoma,—the pain, the changes in the iris and cornea, and the eventual opacity of the lens.

In our ophthalmoscopic examinations, too, we frequently meet with cases in which extravasated blood is dotted over the surface of the retina, while all the other tissues of the eye appear healthy, and no symptom of glaucoma is present.

One of the most marked appearances both in acute and chronic glaucoma, is the uneven condition of the corneal epithelium, which, together with some haziness of the cornea itself, prevents any view of the fundus of the eye by means of the ophthalmoscope; and in the majority of well-marked cases of glaucoma nothing more can be discerned than a faint reddish glow from the retina, without any trace of the optic nerve or retinal vessels being seen. We must bear this fact in mind when reading accounts of so-called glaucoma; for many cases described as of that form of disease may have been really cases of "amaurosis with excavated optic nerve," a condition which may coexist with perfect transparency of all the media of the globe.

Treatment of glaucoma. While confirmed cases of chronic glaucoma had been abandoned as wholly incurable, those of the acute form (under the name of *ophthalmitis interna*, *ophthalmitis arthritica*, &c.) were formerly treated on the antiphlogistic principles, pushed to the severest extremes; profuse bleeding, both local and general, and mercury in salivating doses, being the common means employed to check the progress of disease. Some practitioners regarded gout as its primary cause, and in addition to depletion employed colchicum, or other anti-arthritics.

In spite of every form of treatment, glaucoma remained the *opprobrium* of ophthalmic medicine; and the announcement, therefore, of its curability by means of a simple and easy operation at once attracted general attention. In 1857 Gräfe* published an account of the operation, which he called "Iridectomy;" and he also brought it before the Ophthalmological Congress which met at Brussels in that year. An incision was to be made through the cornea, close to the sclerotic; a considerable portion of the iris was then to be grasped with a forceps, drawn out, and cut off. By this operation it was said the "intraocular pressure," which was the cause of all the phenomena of glaucoma, would at once be removed.

The originator of a new invention is not to be held responsible for all the excesses of his followers and imitators, and therefore it would be unfair to test Gräfe's operation by the strange applications of it which soon followed his announcement. Cases of common inflammation of the sclerotic, implicating to some extent the iris and cornea, and attended with neuralgia,—cases of nuclear cataract in an early stage,—of old corneal opacities combined with dilatation of the pupil,—and other cases equally remote from true glaucoma, came under my observation as having undergone the "new operation," during the first enthusiasm it excited. In one instance, even the reflex from an opaque lens, dislocated into the vitreous chamber of a blind eye, had been mistaken for the peculiar reflex of glaucoma, and the patient was opportunely rescued from "iridectomy," and relieved from his wearing neuralgia, by the removal of the useless globe.

I mention these facts to show how guarded one must be in forming, from reported cases, an opinion as to the value of "iridectomy;" and one cannot but feel how much mischief was done by the broad and unqualified manner in which "iridectomy" was put forward as a "cure for glaucoma," without a due explanation of the limits of its applicability.

A moment's consideration will convince us how large a number of glaucomatous cases must be wholly beyond surgical control; for where serous effusion has already taken place to such an extent as to separate the retina and choroid from each other,—or where, in addition to this effusion, the lens has become opaque and adherent to the iris,—the most ardent admirer of "iridectomy" would surely be inclined to pause.

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* See his essay in the *Archiv für Ophthalmologie* (vol. iii. p. 456), entitled "*On Iridectomy in Glaucoma, and on the Glaucomatous Process.*" Also (vol. iv. p. 127, 1858), "*Farther Clinical Remarks on Glaucoma, Glaucomatous Diseases, and the Curative Effects of Iridectomy.*" These two essays, together with another, "*On Coremorphosis as a Remedy in Iritis and Iridochoroiditis,*" have been translated, under slightly changed titles, by Mr. J. Windsor, and published by the New Sydenham Society (vol. v. 1859).

Although by no means satisfied as to the asserted causal connexion between "intraocular pressure" and the phenomena of glaucoma, I tried the operation of "iridectomy" in the following cases.

1. In "amaurosis with excavated optic nerve;" the globe being hard, the pupil dilated and sluggish, and vision almost lost; the media remaining clear, and the cupping of the optic nerve being extremely well marked. In these cases I wished to test the effect of the operation upon the cupped condition of the nerve.

2. In chronic glaucoma of old standing, where the lens had not yet lost its transparency, but where the following conditions were present: a hard globe, enlarged veins on the surface of the sclerotic, a dilated and fixed pupil, with slaty discoloration and bulging forward of the iris, limitation of vision to mere perception of large and well-lighted surfaces.

3. In "acute glaucoma," as it is now termed, characterised by the following symptoms: sudden impairment, going on almost to loss of sight, rapidly followed by severe inflammation of the sclerotic and conjunctiva; a hazy and finely granular appearance of the corneal epithelium; fixed dilatation of the pupil, with slaty discoloration and bulging of the iris; intense neuralgia throughout the ophthalmic division of the fifth nerve; under the ophthalmoscope, a dull reflex from the retina, without any view of the optic nerve or retinal vessels.

The following is the result of my own experience in the foregoing three classes of disease.

1. In the cases of "amaurosis with excavated optic nerve," no improvement took place either as regards the cupping of the nerve or the patient's vision. This result agrees with Gräfe's own statement,—that such a form of disease is not cured by "iridectomy." The nerve, however, ought to undergo some change if the indentation of its extremity be the result of pressure.

2. Cases of chronic glaucoma, such as those above described, were also little—if at all—benefited. Of course those cases only were selected in which the lens appeared to have retained its transparency. The enlargement of the superficial veins of the globe, the

slaty discoloration and bulging forwards of the iris, and the impossibility of any clear ophthalmoscopic view of the optic nerve and retina, seemed sufficiently to mark these cases, as distinct from those of "amaurosis with excavation of the nerve."

3. I have now repeatedly treated "acute glaucoma" by "iridectomy," with the most striking benefit as respects the relief of pain and inflammation, and restoration of the iris to its healthy appearance.

As regards vision, the results have varied; in some cases the improvement has been very great; in others, which appeared to be of the same kind, as far as external appearances enabled one to judge, little improvement of sight took place. In these latter cases it is possible some complication may have existed, such as apoplexy of the choroid or retina, or very rapid serous effusion between these two structures.

In most of the cases of acute glaucoma which were most benefited by "iridectomy," I removed a much smaller portion of iris than Gräfe recommends; for, in the absence of any clear theory of the *modus operandi* of iridectomy, it seemed to me that if to establish a perfectly free communication between the anterior and posterior aqueous chambers were the chief aim of the operation, the removal of a very large portion of the iris must be unnecessary.

And this brings me to a farther inquiry,—Is the removal of a portion of iris the important and essential part of the operation; or is the free evacuation of the aqueous humour, which incidentally occurs, really the efficient cause of benefit? Undoubtedly, if removal of "intraocular pressure" be the essence of the operation, that object must be effected far more by the evacuation of the over-secreted aqueous humour, than by the removal of a portion of iris which occupies so much less space within the globe.

I have treated several cases of acute glaucoma simply by evacuating the aqueous humour through an opening in the cornea about two lines in extent. In one of these cases there was a return of the inflammation a few weeks after the first evacuation; the operation was repeated with temporary success; but a second relapse took place, and I then removed a portion of the iris with permanent benefit. In the other cases the simple evacuation of the aqueous humour through a large opening was found sufficient. When the iris adhered to the wound, or a very slight prolapse occurred, so that the pupil remained somewhat enlarged and extending to the margin of the cornea, the cure seemed to be more surely permanent.

SCROFULOUS AND MALIGNANT DEPOSITS WITHIN THE EYEBALL.

As the present treatise on Diseases of the Eye forms part of a General System of Surgery, special sections of which describe the pathology of morbid growths, whether malignant or otherwise, I have not thought it necessary to go into the subject of such growths, except just so far as they have relation to diagnosis and treatment in connexion with the eye.

Scrofulous and encephaloid deposits, differing so essentially from each other in their histology, and in the ultimate effects they produce upon the eye, nevertheless present at a certain stage of their progress almost the same external appearances.

It is chiefly in infants and young children that encephaloid and scrofulous deposits take place, while melanosis is the form more commonly met with in adults.

In scrofulous and encephaloid cases, the first symptom noticed is a yellowish reflection from behind the pupil, having more or less of a metallic brilliancy, like that seen in a cat's eye. The Surgeon will find it difficult to form a decided diagnosis at this early stage of the disease. The pupil for a time retains its mobility, and it will therefore be necessary to apply atropine before using the ophthalmoscope; the employment of which, I need hardly say, is often very difficult with timid or restless children.

The retina will be found thrust forwards by an irregularly lobulated mass, and enlarged vessels will be seen ramifying over the uneven surface. As disease advances the pupil becomes dilated and fixed, so that the ophthalmoscope can be used without any previous application of atropine. The mass slowly advances until it almost touches the hinder surface of the lens, which, up to this period, retains its transparency. Hitherto the patient suffers little pain, there is hardly a trace of increased vascularity about the conjunctiva or sclerotic, and the general health appears little, if at all, affected.

In the second stage, however, both redness and pain set in. The lens becomes cloudy, so that the deposit at the fundus of the eye can no longer be recognised, except by the indistinct yellowish tint which it transmits through the lens. The sclerotic and conjunctiva become deeply injected, and, so soon as the lens begins to press against the cornea, there is a considerable flow of tears, with intolerance of light. The patient becomes restless and feverish, with loss of appetite and irregular action of the bowels. In this second stage, the eyeball becomes enlarged and the cornea opaque.

The sclerotic bulges at one spot, as if matter were forming there, or it becomes soft and fluctuating in several places. Usually the softening is most marked just behind the upper margin of the cornea.

Up to this point it will have been difficult, if not impossible, for the most experienced Surgeon to pronounce, with absolute certainty, whether the disease under his observation be scrofulous or encephaloid. In either case the sclerotic usually gives way at the most projecting spot, the humours escape, frequently the lens also, and, for a short period, pain ceases, and the patient's general health improves.

If the case be one of *scrofulous* deposit, the disease may now begin to subside, the globe slowly wasting, until, eventually, a mere nodule remains at the bottom of the orbit. Indeed, in some scrofulous cases the globe does not burst at all; but, having become enlarged to a considerable extent, slowly begins to shrink, and at last undergoes atrophy. After destroying one eye, scrofulous disease will sometimes attack the other, with the same result.

But should the deposit be *encephaloid*, a farther change now begins. A soft vascular growth sprouts forth from the opening in the sclerotic, through which the humours of the eye had escaped. This fungous mass enlarges with great rapidity, frequently attaining an enormous size, and exudes a profuse fœtid sanies, which, by exposure to the air, dries into brownish crusts, giving to the tumour almost the appearance of a sponge. The separation of one of these crusts, or a very slight touch, often causes bleeding from the vessels which traverse the tumour in every direction. The patient becomes more emaciated and weak, and, after several months of suffering, dies, either from repeated loss of blood, or from the simultaneous development of malignant disease in the brain or some other important organ.

Melanosis is the form of malignant disease which attacks the eye in adult life. Sometimes the melanoid deposit is so abundant that the whole mass acquires a brownish-black tint, in other instances it is only partially distributed through an encephaloid growth. Although more commonly commencing in an eye not previously diseased, melanosis sometimes attacks one which has already become useless from destructive inflammation.

It is between the choroid and retina that melanotic deposit most frequently takes place; and the visual power of a portion of the retina is often retained to a remarkable degree, while the rest of it has become completely displaced. The same remark holds good also in encephaloid cases. The ophthalmoscope is of course our only means for arriving at an accurate diagnosis of melanotic deposit within the vitreous chamber. When it has burst through the coats of the globe, its dark colour and general appearance would at once proclaim its real nature. Occasionally, melanosis appears to originate outside the globe, in connexion with the conjunctiva, subsequently involving the sclerotic and other tissues.

The medical *treatment* of encephaloid and melanotic deposits within the globe, as in other parts of the body, can be only palliative. We may lay it down as a rule in the treatment of such affections, that, while we know of no substance which can cure them, they may often be kept in check for a considerable time by supporting the general powers of the patient; and the more we are able to do this, the slower will be the progress of the malignant growth, and the less tendency will it evince to involve the neighbouring tissues. Strict attention to the patient's diet, and to the regulation of his health by means of suitable tonic medicines and pure air, will often retard to a remarkable degree the fatal termination of the disease.

In endeavouring to form an opinion as to the curative results of *surgical operation* in malignant disease of the eyeball, we must altogether dismiss, as untrustworthy, the records of our older surgery. For many of the eyes, said to have been removed without any return of disease, were doubtless affected with scrofulous deposit, which, as I have said, at a certain stage of its progress, so closely resembles the encephaloid form. Removal of the eyeball should be undertaken only after the most careful examination, both local and general. The Surgeon should inquire into the mode in which the various bodily functions are performed, so as to assure himself that no appreciable deposit of a malignant kind has taken place in any of the viscera. He must, as far as possible, ascertain that the encephaloid or melanotic mass is fairly enclosed within the fibrous case of the eye, without having involved the optic nerve, or penetrated through the sclerotic into the cavity of orbit. These conditions cannot be absolutely determined; but attention to certain points will help the Surgeon to make some approximation towards a correct diagnosis. If the eyeball be thrust forwards, without its actual volume being increased,—if it be habitually turned in any particular direction,—if it be fixed, or only movable to a very slight degree,—above all, if the point of the little finger, passed backwards by the side of the globe, encounters any resisting mass within the orbit, it may fairly be assumed that the morbid deposit extends beyond the cavity of the eyeball; and in such a case its removal would be of doubtful success. Even under the most favourable circumstances, the Surgeon, when convinced of the existence of a malignant growth, would give a most guarded prognosis; for in no class of operations for the removal of such disease are the statistics more discouraging than in those relating to the eye.

CHAPTER IX.

SHORT-SIGHT (*Myopia*); LONG-SIGHT (*Presbyopia*); COLOUR-BLINDNESS (*Acritochromacy*); NIGHT-BLINDNESS (*Hemeralopia*).

SHORT-SIGHT.

THE term "short-sighted" is often popularly used as synonymous with "dim-sighted." But the defect I am about to notice, arising from some fault either in the refractive or the adaptive power of the eye, allows the patient to see near objects with the utmost distinctness, while distant ones appear dim and confused. A short-sighted person may possess the acutest powers of vision for near objects, or he may see them only when near, and even then indistinctly. The term "short-sighted," or "myopic," applies exclusively to his *range*, not to his *power* of sight.

Another popular error attributes short-sight to over-convexity of the cornea. But careful examination of a few cases will convince the observer of the fallacy of this opinion; and, indeed, one has but to notice the nearly flat cornea of the short-sighted fish, and the convex cornea of the far-seeing bird of prey, to feel certain that the condition termed *myopia* must depend upon causes quite independent of this portion of the eye.

It is probable that the cause of their defect varies in different short-sighted persons. In all of them the rays which ought to come to a focus upon the retina, converge to a point in front of it. This may arise from the lens being too convex, or from elongation of the globe in its antero-posterior axis, or from an unusual power of adjusting the eye to near objects by changing the position of the lens.

Short-sight is frequently hereditary in families. It is one of the defects incident to a certain state of civilisation, being comparatively rare among savage or uncivilised nations, and among those persons who lead an out-of-door life; while it is common among studious and literary men and artists, and among artisans engaged in minute and delicate manipulations.

It is sometimes met with in early childhood; but, in the great majority of cases, it gradually comes on a little before puberty, and it continues to increase up to about the age of twenty-five, when the focus settles into that which remains permanent for the rest of life.

It is a popular fallacy to suppose that short-sighted persons become far-sighted in old age; "their sight then improves," it is said. This is by no means the case; but people are so accustomed to see the aged reading with spectacles, that the fact of an old person reading without them—as he will be sure to do if short-sighted—seems to give him an advantage over those of his own age, only to be accounted for by some great improvement having occurred late in life.

When extremely short sight is met with in a child, so that, in reading, the type is held within three or four inches of the eyes, and even then is not clearly seen, the Surgeon should very carefully examine the condition of the patient's lenses; for in such a case congenital cataract, of a very peculiar kind, will sometimes be detected (see p. 800). The slight interstitial haziness of the cornea, resulting from some forms of keratitis, will also induce the patient, in reading, to hold the type very close to the eyes. This defect, like that just noticed, must of course be carefully distinguished from true *myopia*.

When describing the ophthalmoscopic appearances of the retina (p. 781), I mentioned that a white crescentic patch was to be seen by the side of the optic nerve in every well-marked case of short-sight. The causal connexion between the crescent and the myopia is by no means clear; but it appears from dissections, that whenever this crescent exists, the sclerotic in the immediate neighbourhood of the optic nerve is thinner than natural; and it has been suggested that the pressure of the recti muscles upon an eyeball thus weakened would have the effect of elongating it in its antero-posterior direction.

Much ingenuity has been expended in devising means to prevent the advance of myopia in early life, and a form of reading-desk has been contrived by the use of which a child might be gradually trained to adapt the eyes to longer distances. But no stretch of ingenuity, I fancy, will ever discover children or young persons willing to submit to the constraint of such mechanical contrivances, nor can the desk be always at hand. Those who are old enough to appreciate the inconveniences of being through life the subjects of short-sight, may, to a certain extent, check its progress, by habitually holding their book at the greatest distance from the eyes compatible with distinct vision.

The optical remedy for short-sight consists, I need hardly say, in concave glasses of a focus suited to the individual case. It very often becomes a question whether a young person who is short-sighted should, or should not, wear spectacles. This must be determined by circumstances. Some children, from an early age, are so extremely short-sighted, that they can read ordinary type only when the page is brought within two or three inches of the eyes. To deny the use of glasses to such patients deprives them of many of the ordinary means of education, and at the same time induces awkward and grotesque attitudes. Care should of course be taken that the first pair of glasses should be only just sufficiently concave to compensate for the myopic defect of the eyes, and that any increase in the degree of concavity should be made only when it becomes absolutely necessary. Young persons who are but slightly myopic may require a low concave power only when reading music. When they have reached the age at which the sight settles into its permanent focus, they may, according to circumstances, either permanently adopt spectacles, or occasionally use a hand-glass. The latter should always be made with a glass for each eye. The practice of using a single glass is most prejudicial to the eye which is left unemployed, and, by disuse, it becomes permanently impaired.

Great confusion has hitherto existed in consequence of concave glasses being numbered by opticians in a manner purely arbitrary. *Convex* glasses have almost uniformly been distinguished by numbers expressing their true focal distance. Thus, "No. 24 convex" implied that the focus of the glass was 24 inches, and so on. But with concave glasses, "No. 1" was *least* concave, "No. 2" was more so, and thus each successive number implied an increased concavity. And again, "No. 1" was not of any fixed focus, nor did the numbers follow in any regular gradation. The simple plan adopted by the German opticians, which has of late been introduced into this country, obviates all confusion. The curve of the glass, whether convex or concave, determines its number. That of the concave glass "No. 24," for instance, would exactly fit into the curve of a convex glass of 24 inches focus.

LONG-SIGHT.

Presbyopia, as applied to a form of vision in which small and near objects appear indistinct, while distant ones are seen clearly, is a very ill-chosen term; for this condition is by no means an exclusive result of old age. It is occasionally met with in young persons,—even in children,—and it is also a frequent result of exhaustion in the nervous and muscular system of the eye in consequence of over-use. (See remarks on "Impaired Vision," p. 765.)

Long-sight probably depends upon different causes in different persons; while in short-sight the rays of light, entering at the pupil, come to a focus in front of the retina, in long-sight they come to a focus behind it; and this may be due to insufficient convexity of the lens,—from want of power to move it in that slight degree necessary for due adjustment,—or from the antero-posterior diameter of the globe being too small.

Persons who in early life have had remarkably acute sight for distant objects, commonly find, as they approach the age of fifty, that reading becomes more and more difficult. The book is placed farther off, at last held at arm's-length; the effort is attended with a sense of strain in the eyes, and can sometimes be kept up for only a few minutes together. Glasses of a low convex power—say of thirty or twenty-four inches focus—at once remedy the defect, and reading is resumed with ease and comfort.

In mentioning fifty as about the age at which this difficulty of adjustment for near objects is first experienced, I speak only of the more usual course of things; with some long-sighted persons the difficulty comes on earlier,—soon after thirty,—with others not till after fifty. I have occasionally met with rare cases in which the defect existed in early life, having been experienced by children when first sent to school, at ten or eleven years of age. In these exceptional instances, to refuse the aid of convex glasses, is, to a great degree, to deny the child the advantages of education; but it should be well ascertained that the want of adjustment depends upon some inherent defect in the optical condition of the eyes, and not upon temporary circumstances (see p. 766).

In the common forms of *presbyopia*, properly so called, convex spectacles remove all difficulty in reading. The lowest power should be chosen which will enable the patient to read without effort, and without being sensible of any magnifying effect being produced upon the type. The glasses should be worn only during reading or writing; or if any aid is required for seeing distant objects, a less convex form of glass should be used for observing them.

FAULTY PERCEPTION OF COLOURS.

The following list comprises only a portion of the many terms invented to designate this affection: *achromatopsia*, *chromatopseud-*

opsia, *chromatometablepsia*, *chromatodysopsia*, *chromatopseudoblepsia*, *dyschromatopsia*. These words, it will be observed, all imply difficulty or inability to *see colours;* but in fact the subjects of this affection are not insensible to all, but only to some colours, while others are seen perfectly. The term *colour-blindness*, employed by Wilson,* is on this account objectionable. *Daltonism* † commemorates the faulty perception of an individual, without conveying any notion of the nature of the defect. I have suggested the word *acritochromacy*, ‡ as implying "inability to discriminate between colours," which pretty nearly defines the true nature of the affection.

On investigating the reported cases of "acritochromacy," the defect appears in most instances to resolve itself into inability to perceive red; and the compound tints suggesting doubtful impressions are those into which red enters to a greater or less extent. Yellow seems to be always appreciated, and blue almost always.

The cause of the defect probably resides not in the eye itself, but in that portion of the brain to which the impressions of light are ultimately conveyed. Hitherto very few dissections have been made of the eyes of "acritochromatic" persons. Dalton had supposed a blue tint of the vitreous humour to be the cause of his own peculiarity, and, in accordance with his express wish, his eyes were examined after death, but nothing unusual was discovered.

Acritochromacy may take place as a temporary morbid symptom. Some years ago a very intelligent and sensitive little girl, ten years old, was brought to me in consequence of almost total blindness, which had come on within the preceding four days. She was unable to guide herself, and, if left alone, could not avoid the articles of furniture in the room. She with difficulty perceived a sheet of paper lying on the floor, and, of course, was wholly unable to distinguish the largest type. She had been much excited by the emulation of a school-competition, and had taxed her memory considerably by learning by heart. Slight dilatation and sluggishness of the pupils were the only ocular symptoms; but she dreamed vividly, occasionally felt faint during the day, and had numbness and formication in the left leg and foot. I enjoined complete rest, and prescribed iron in small doses. Within a week she could trace lines of type as streaks, but was quite unable correctly to appreciate colours.

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* See *Monthly Journal of Medical Science*, Edinburgh, July 1854, p. 1.

† From Dalton the chemist, who published his own case in the *Memoirs of the Literary and Philosophical Society of Manchester*, 1798, vol. v. p. 28.

‡ *'Ακριτοχρωματία.*

She had no difficulty with yellow and blue, but mistook all tints containing red. Ten days later her general health was restored, and with a little pains she could read the type of a leading article in the *Times;* but her appreciation of colours was still imperfect. At the end of a few weeks all defect of sight was gone; she read the smallest type, and her power of discriminating colours was quite restored.

Wilson has insisted upon a very important practical point connected with "colour-blindness," as he terms the defect, namely, that persons employed on railways and elsewhere, where coloured lights are used as signals, should be previously tested as to their power of perceiving colours with perfect accuracy.

There seems to be no cure, or even palliation, of a defect which appears to depend upon a congenital want of appreciative power in the brain itself.

HEMERALOPIA AND NYCTALOPIA.

Hemeralopia,—literally "day-sight,"—is a term used to designate a peculiar form of intermittent blindness, the subjects of which see perfectly in broad daylight, but lose all power of perceiving objects as soon as the sun has set, and twilight commences. The persons in whom the affection is met with in this country are those just returned from sea-voyages, especially from the East or West Indies. It is also frequent among the natives of the inland parts of India, who attribute it, as our own sailors do, to sleeping exposed to the moonbeams.

The real cause of hemeralopia appears to be exhaustion of the nervous power of the retina from over-excitation by the sun's rays, so that the part is rendered incapable of appreciating the weaker stimulus of twilight or moonlight. Exposure to tropical light, however, is not the sole cause of the affection; for I have met with it in persons who had never quitted the temperate regions of the globe; but in most of these latter cases the complaint had shown itself after long voyages, which had subjected the patients to exhausting toil and exposure to severe weather, while deprived of a proper supply of fresh provisions and vegetables.

In these latter cases I have commonly found that a few weeks' residence on shore, with a mixed vegetable and animal diet, and the use of quinine, has restored vision to a healthy state.

Nyctalopia,—"night-sight,"—would imply inability to see by daylight, the exact converse of hemeralopia. In a certain sense, patients affected with that irritable form of corneal inflammation commonly called "strumous ophthalmia," might be called nyctalopic, so unable are they to bear strong light, and so willing to open the eyes and look about them in the dimness of twilight; but, apart from inflammation, I have never met with nyctalopia to the extent described by authors; and I am inclined to consider the affection an imaginary one, invented, as it were, to form a companion disease to the hemeralopia just described.

CHAPTER X.

DISEASES OF THE LACRYMAL APPARATUS.

THE lacrymal apparatus comprises the lacrymal gland, which secretes the tears,—the puncta and canaliculi, which convey them into the lacrymal sac, where they temporarily accumulate,—and the lacrymo-nasal canal, whereby they are finally conveyed into the lower chamber of the nose.

If we consider the small calibre of the canaliculi, we can readily understand that a very slight degree of thickening in the delicate membrane which lines them, or a trifling displacement of the puncta, can suffice to disarrange the mechanism of taking up and carrying on the tears; and accordingly we find that watering of the eye (*epiphora*) is a frequent symptom in various forms of conjunctival inflammation. It also constitutes of itself a troublesome condition, which is constantly being brought under the Surgeon's notice.

If the puncta are quite impervious, of course the tears must trickle down the cheek as fast as they are secreted. A contraction or stricture of the puncta or canaliculi will cause a less complete overflow. If the lacrymo-nasal canal be strictured, or its outlet obstructed, the tears passing into the sac will accumulate there, and, together with the pent-up mucus, will form a swelling termed *mucocele*. Unless relief is obtained, the distended sac becomes inflamed, and pus is formed, which eventually discharges itself through an opening in the skin, constituting true *fistula lacrymalis*. This term, however, is often incorrectly applied to abscess of the sac without any perforation of the skin.

When a case comes before us in which there is a continual watery state of the eye, our attention should be at once directed to the puncta. These apertures, in a healthy state, are in contact with the ocular conjunctiva, so that, to bring them into view, it is necessary to draw the margin of the tarsus a little away from the eyeball. If the conjunctiva lining the lower lid has become considerably thickened from chronic inflammation, the edge of the tarsus may be so much everted as to cause the punctum to face upwards, or even directly forwards. In such a position it can no longer take up the tears, which accordingly run over the edge of the lid. In extreme cases of *lippitudo* and chronic ophthalmia, the puncta, still retaining their natural position, are sometimes found to be so completely obliterated, that their position can no longer be detected.

If the puncta are in their natural position, and their openings appear unobstructed, and yet no tears can be made to regurgitate through them when the point of the finger is firmly pressed against the lacrymal sac, just below the tendon of the orbicularis palpebrarum, we may suspect some stricture to exist in the canaliculi. We can ascertain this only by exploring them with a fine probe. This may seem to be a very simple matter; but it requires considerable care and tact, without which much serious mischief may result. The membrane lining the canals is extremely delicate, and any want of gentleness in passing the probe may tear the membrane, and so give rise to fresh obstruction. We must bear in mind the abrupt turn which the canal makes at a short distance from the punctum. In passing a probe into the lower canaliculus, the instrument should be directed almost vertically downwards for about half a line, and then turned inwards towards the nose, in which direction it will pass on, should no stricture exist, until its point strikes against the inner wall of the sac, where it lies against the bone. During the whole process of introducing the probe, the tarsi should be kept on the stretch, by drawing outwards the external canthus.

Except to a practised hand, it is often difficult to detect whether the point of the probe is arrested close to the junction of the canaliculus with the external wall of the sac, or whether the point has reached the internal wall. In the former case any onward pressure with the instrument produces a slight dragging of the tarsus; whereas contact of the probe with the inner wall of the sac not only conveys to the hand a peculiar feeling of firm resistance, but at once causes all movement of the tarsus to cease.

If the canaliculi be found free from stricture, and the sac forms a distinct prominence below the inner canthus, it is pretty certain there is an obstruction at the lacrymo-nasal canal. If this canal be perfectly closed, while the canaliculi are free, firm pressure of the finger on the swollen sac will cause its contents to escape at the puncta; but if the canal, although narrowed, be pervious, steady pressure in a direction downwards and a little backwards, may overcome the resistance of the stricture; the swelling then suddenly yields, and the contents of the sac pass into the nose.

When we consider that the membrane lining the outlet of the lacrymo-nasal canal is that common to the chambers of the nose, we cannot be surprised that catarrhal inflammation of this membrane should be a frequent cause of lacrymal obstruction. If pressure on the sac suffices to empty its contents into the nostril, the inconvenience of the partial obstruction at the outlet may be kept in check by the patient taking care frequently to make this pressure, and to use at the same time other means for restoring the lining membrane of the sac as well as that of the nose to a more healthy condition. But if this pressure is omitted, and the tears and mucus are allowed to collect and to distend the sac, this distension, under some attack of catarrhal inflammation, may suddenly transform the chronic disease into an acute one. Pain is then felt in the part; the lids become red and puffy,—sometimes assuming an erysipelatous appearance; and the patient is quite unable to separate the tarsi. The swollen sac feels hard to the touch, and even slight pressure on it is extremely painful, while it fails to press out any thing from the puncta.

These symptoms show that suppuration is taking place within the sac. If the case is left to itself, the pus escapes by bursting through the skin, and the opening frequently remains fistulous, allowing the tears, which have passed through the puncta into the sac, to trickle out upon the cheek, thus constituting a true *fistula lacrymalis*. After all inflammation has passed away, and the redness and swelling which attended the formation of the abscess have disappeared, the fistula often contracts to such a small aperture, that, were it not for the tears which slowly distil from it, the opening would hardly be perceptible. It is about the size of a pin-hole, and almost resembles one of the puncta in minuteness of aperture.

Treatment of lacrymal obstructions. These obstructions, varying as they do from a slight thickening of some portion of the lining membrane of the sac or nasal canal, causing occasional watering of the eye, up to a total occlusion of the nasal canal, with displacement or stricture of the puncta and canaliculi, cannot of course all require the same kind of treatment. Slight cases of thickening of the lining membrane of the sac, if of recent date, may be much benefited by the repeated application of small oval blisters, about half an inch long, over the sac. Astringent solutions of alum or tannin may, at the same time, be dropped into the corner of the eye, so that they may follow the course of the tears, and thus reach the thickened membrane. This object may be facilitated by slitting up the canaliculus in the manner hereafter to be described. Each time the drops are used, the sac should be previously emptied, by pressing the point of the finger upon it in a downward direction. Should the lining membrane of the nose be in a thickened state, injections of astringent lotions into the nostril are of service; and in all cases attention to the general health and suitable tonic medicines are indicated.

Warm water-dressing, by means of lint and oiled-silk, should be applied whenever acute inflammation of the sac sets in with the symptoms I have described. This form of applying warmth and moisture is, in all affections of the lids and parts about the eye, to be preferred to poultices, as the latter frequently produce a troublesome form of eczematous eruption. Diligent application of water-dressing for four-and-twenty hours will frequently subdue acute inflammation of the sac to such an extent that not only do the redness and swelling of the lids disappear, but the thickening of the internal membrane gives way; so that gentle pressure over the sac suffices to empty its contents into the nose, and the case returns to its chronic condition. Should this not be the case, an incision must be made into the sac, and exit given to the pus.

There is hardly any form of local disease which has given rise to a greater variety of surgical treatment than chronic distension of the lacrymal sac, and stricture of its nasal duct. The distended sac has been compressed by an apparatus of pads, adjusted by means of springs and screws. The strictured sac or duct has been subjected to gradual dilatation by means of strings of catgut, introduced through an opening made into the sac, and brought out into the nostril; strings of increasing thickness being used as the canal would admit of their passage. Dilatation of the stricture was at one time attempted from below, by means of curved sounds, introduced into the sac from the nostril; but these instruments were difficult to introduce, there was great risk of breaking with them some of the fragile bones in the neighbourhood of the nasal duct, and they could not reach a stricture situated high up towards the entrance of the canaliculi. At one time metal tubes were placed in the cavity of the sac, which were intended to be healed in, and permanently to occupy its cavity; but Nature, disliking foreign bodies, even when introduced by a Surgeon, always rebelled against them, and did her best to dislodge them, either upwards or downwards. The *style* maintained its ground longest, and until recently formed the *ultima ratio* in every case of obstinate lacrymal obstruction. It was made long enough to reach from just below the tendon of the orbicularis palpebrarum, where an incision was made into the cavity of the sac to admit it, to near the floor of the nostril. The upper end was furnished with a nail-like head, to support the style in its proper position ; and it was intended that the tears, entering by the puncta and canaliculi, should come into contact with the piece of metal, and glide down by the side of it into the nose. The style was to be taken out every day, cleansed and replaced ; and at first the cure appeared perfect; but patients, from timidity, awkwardness, or carelessness, neglected this precaution, the instrument was seldom, in some cases never, removed, and eventually it become encrusted with earthy deposit from the tears, or was consumed by oxydation; the skin around the nail-shaped head became drawn in, and at the same time blackened with the sulphuret of silver,—in short, the style, so highly praised at first, became at last a source of annoyance and disappointment.

About ten years ago, Mr. Bowman* suggested a very simple and useful operation, which, in many instances, suffices to cure *epiphora* resulting from contraction or displacement of the puncta, while at the same time it affords a ready access to any obstruction that may exist in the course of the sac or lacrymo-nasal canal.

Suppose that, in consequence of chronic ophthalmia, or from any other cause, the lower punctum has become displaced, so that, instead of facing towards the eyeball, it is directed upwards and forwards ; the tears in such a case will run over the edge of the lid ; and the object of the Surgeon must be to transfer, as it were, the displaced punctum to a position where it can catch the tears before they overflow the border of the tarsus. The lid being put upon the stretch, a fine grooved director, or, in default of that, an ordinary punctum-probe, is to be passed along the whole course of the canaliculus, and held firmly there, while a fine sharp-pointed knife is run along the probe, as far as the caruncle, so as completely to lay open the canal, and thus extend its orifice backwards to the point where the tears accumulate.

An ordinary extraction-knife may be employed for making this incision ; but I prefer to use one of the small narrow-bladed knives originally invented by Sir William Adams for his operation of artificial pupil; or the "knife-needle" devised by Dr. Hays for cutting up the lens.

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* *Medico-Chirurgical Transactions* for 1851, p. 338.

For several days after the incision has been made through the upper wall of the canaliculus a probe must be passed along its track, to prevent the lips of the wound growing together. In some persons it may be necessary to use the probe for ten days or more; in other cases there is hardly any disposition in the edges of the wound to unite.

When the overflow of tears depends simply on faulty position of the punctum, this laying open of the canaliculus may of itself effect a cure. In cases of obstruction in the lacrymal sac or its nasal duct, the incision affords an easy access to the seat of stricture.

Occasionally, however, another complication exists in a narrowing of the canaliculus just at its point of communication with the sac, which may prevent the passage of a probe sufficiently large to act upon the stricture. In such a case a small straight cannula, containing a lancet-shaped point, which may be protruded or withdrawn by means of a spring,—in fact, Stafford's instrument for dividing urethral stricture, made on a miniature scale,—must be carried along the canaliculus, and employed upon the constricted spot.

The probes for dilating strictures in the sac or its canal must be of various degrees of thickness, but all sufficiently strong to sustain the requisite amount of pressure without bending. They are best introduced by the Surgeon standing behind the patient; and it will be found advisable to avoid using those of too small a size, as they are of course more likely than those of a larger size to catch in a fold of membrane, or even to pierce the membrane covering the bony walls of the canal.

The tarsus being put on the stretch, the probe is passed along the newly-opened canaliculus until its extremity strikes against the inner wall of the sac. Still keeping its extremity in contact with this part, the probe is raised to a vertical position, and then carefully carried downwards to the seat of stricture. The canal inclines somewhat backwards, and this inclination is to be carefully borne in mind. The Surgeon must feel his way with the point of the instrument, and be on his guard against using unnecessary force. In cases of old dilatation of the sac, its relaxed lining membrane readily catches in a fold against the point of the probe, and the Surgeon must learn to discriminate between a check arising from this cause, and the obstacle encountered by the instrument becoming impacted in the constricted lacrymo-nasal canal. The length of the instrument which has been passed in, and the patient's own feelings, will prove whether the point of the probe has entered the nasal cavity.

It sometimes happens that, immediately after the first passage of the probe, the Surgeon is able, by pressure over the sac, to force all its contents down into the nose; but if there has been much difficulty in passing the instrument, the membrane becomes swollen, and will allow the contents of the sac to pass only after the swelling has been relieved by fomentation.

No fixed rules can be laid down as to the frequency with which the probe is to be used, nor as to the length of time required for a cure. This will vary from a few weeks to several months, and relapses frequently occur long after the stricture appears to have been completely overcome. Too frequent use of the probe will set up irritation, and induce a more abundant muco-purulent secretion. When this takes place, the probe must be laid aside for a week or two, and fomentation, with water-dressing at night, be substituted.

During the whole course of treatment by means of the probes, the patient must never neglect several times a day to press out the contents of the sac, endeavouring to do this in a downward direction; or, if this cannot be effected, by pressure through the puncta.

Those who are about to treat a case of long-standing lacrymal obstruction by the passage of probes, should clearly understand how much care, tact, and patience such an undertaking requires. In consequence of the minuteness and delicacy of the parts concerned, the treatment of a stricture in the lacrymo-nasal duct demands even greater care and skill than that of a stricture in the urethra; and I am sure that those who have seen much practice will bear me out in asserting, that by far the greater part of obstinate and dangerous cases of the latter kind are due to meddlesome surgery rather than to any original disease.

The Surgeon must bear in mind that the walls of the lacrymal sac and duct are composed of extremely brittle and fragile bones, and the rough introduction of a probe may either break some of these, or tear away the delicate and vascular membrane which covers them. Besides, as the lacrymo-nasal canal is a bony tube, all thickening of its lining membrane must take place concentrically; and therefore any undue violence, by setting up inflammation, is sure to increase instead of lessening the cause of stricture.

Even when all possible care and skill have been employed, the treatment of stricture in the lacrymal passages, by the means just described, is often extremely tedious; for the affection may be complicated with great dilatation of the sac, caries of the adjacent bones, or false passages of various kinds, resulting from previous mismanagement.

Dacryolithes. This term has been applied to certain concretions which are sometimes met with in the lacrymal passages, in the canaliculi, or in the sac, caused by the earthy salts contained in the tears becoming deposited in the form of a calculus. Watering of the eye, repeated attacks of inflammation in the sac, or swelling and suppuration about the canaliculus, and pain when the part is pressed upon, are the more obvious symptoms. A probe carefully passed into the canaliculus, or through it into the sac, would detect the presence of the concretion, which must be cut upon, and extracted with a scoop or other instrument.

Irritation of the lacrymal passages is sometimes caused by the intrusion of a detached eyelash into one of the canaliculi. In this curious accident the hair enters at the punctum, and passes on as far as the abrupt bend which the canal makes at about a line's distance from the orifice. Here it is arrested; its point protruding to a greater or less extent, and irritating the caruncle and semilunar fold. The symptoms induced are a pricking and itching about the inner canthus, with reddening of the neighbouring conjunctiva. If the hair be short, its point will protrude so little as to make it very difficult of detection; on its withdrawal, all irritation at once ceases.

DISEASES OF THE LACRYMAL GLAND AND ITS DUCTS.

The works of foreign writers present a formidable array of diseases affecting this gland, almost every form of acute and chronic inflammation, and enlargements, both simple and malignant, being recorded; while our own countrymen appear to have met with but few cases of the kind. My own experience would lead me to believe that, compared with the other glandular structures of the body, the lacrymal gland is very rarely the seat of disease. Its sheltered position beneath the projection of the frontal bone guards it, to a great extent, from external violence, and it appears but seldom to participate in the inflammation of neighbouring tissues.

One rare affection consists in an accumulation of tears in one or more of the obstructed excretory ducts, whereby a cyst-like tumour is formed in the upper lid (*dacryops*), becoming very visible when the lid is everted. If one of these enlargements is punctured, without attention being paid to the after-treatment of the case, the opening is apt to become fistulous (*dacryops fistulosus*), the lacrymal secretion continuing to distil through a minute aperture in the skin. Such a case may be treated on the same principle as a fistula of the parotid gland, namely, by passing in at the opening a thread, which, having been carried through the thickness of the lid, and brought out at its conjunctival surface, has a small knot made at one end. This knot is then drawn into the fistula, and, by continued traction of the other end, is made to ulcerate its way through the conjunctival surface. The tears being thus diverted, the fistulous orifice in the skin may be closed by paring and uniting its edges.*

Should the lacrymal gland really become the seat of malignant deposit, or should it be deemed advisable to extirpate it on account of chronic enlargement, or for any other cause, the operation would be a simple one, and would offer nothing worthy of remark.

In the only instances, three in number, where I have myself extirpated the gland, it was not the seat of disease, but was removed to do away with the inconvenience of the overflow of tears, the puncta and canaliculi having been wholly destroyed by extensive burns.†

CHAPTER XI.

DISEASES OF THE EYELIDS.

So many various tissues enter into the formation of the eyelids that they must necessarily be liable to a great variety of diseases; but it would be absurd to attempt a description of all the morbid conditions which they share with the other portions of the common integument of the body.

The *orbicularis palpebrarum* is subject to a spasmodic twitching of some of its fibres, usually those of the lower lid, producing a visible quivering of the skin, popularly termed the "live-blood." To persons of an irritable nervous system this becomes teasing from its frequent recurrence. It is commonly the result of intestinal irritation, especially that produced by ascarides; and a few doses of purgative medicine, followed up by tonics, usually suffice to put an end to the annoyance.

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* See a well-reported case of *dacryops*, by Mr. Hulke, *Ophthalmic Hospital Reports*, vol. i. p. 287, 1859. In this instance a loop of thread was made to include a certain portion of the conjunctiva.

† In one of these cases an artificial pupil I had made would have been rendered almost useless, in consequence of the flooding of the eye with tears, had their secretion been allowed to continue. See *Guide to the Practical Study of Diseases of the Eye*, 2d edition, 1859, p. 417.

Epicanthus is a term applied to a slight deformity, sometimes observed in children, consisting in a crescentic fold of redundant skin at the inner corner of each eye, partly or wholly concealing the caruncle. It is associated with a depressed form of the nasal bones, and if, in after life, the bridge of the nose becomes more prominent, the fold of skin, to a certain extent, diminishes, although it never wholly disappears. *Epicanthus* imparts to the face an unpleasant, Chinese expression; and the only cure is by pinching up and removing a vertical fold of skin on the median plane, just between the eyebrows, and then bringing the wound accurately together.

Ptosis, or drooping of the upper lid, may exist in various degrees, producing merely a slight deformity, or becoming complete, so as wholly to obstruct vision. It will be spoken of under "paralysis of the third nerve." In some cases of congenital drooping of the lids it is possible that the levator palpebræ muscle may be altogether wanting. Patients with this defect have no power of moving the lids except by calling into action the occipito-frontalis muscle. The lids do not present that transverse fold in the skin, which, in the normal state, corresponds to the upper part of the eyeball, but are smooth and unwrinkled from the eyebrow to the tarsus, while the forehead is furrowed by the frequent action of the occipito-frontalis.

The terms *entropion* and *ectropion* are respectively applied to the inversion and eversion of the margins of the lids.

The simplest form of *entropion* is that which is occasionally met with in children, the subjects of irritable ophthalmia, as a result of spasm of the orbicularis palpebrarum. Extreme intolerance of light induces this muscle to contract so often and so forcibly that at last the lower tarsus rolls over against the globe, causing an inversion of the eyelashes, which greatly adds to the patient's distress. Contractile collodion, painted on the skin of the lower lid, draws the part into a proper position, and keeps it so while suitable remedies are being employed to subdue the original disease.

A similar spasmodic inversion of the lower lid happens to old persons, in whom the skin is relaxed and the tarsus flaccid. The muscular contraction is repeated until at last the lid becomes so rolled upon itself, that both the cilia and the tarsus are completely hidden, and the border of the lid appears to be formed of common integument. In these cases of extreme inversion the irritation is really much less than when the inversion exists to a slight degree. For in the latter case the points of the cilia are brought into direct contact with the ocular conjunctiva, while in the former case the tarsus rolls over so completely, that the points of the cilia become buried in the fold of palpebral conjunctiva, and consequently do not come into contact with the globe at all.

A far more severe and obstinate kind of entropion is that which follows chronic inflammation of the palpebral conjunctiva, especially neglected or maltreated purulent ophthalmia. The upper tarsal cartilage becomes so much curved upon itself, that the whole range of eyelashes turns backwards against the globe. This curving of the tarsus is often aggravated by the long-continued application of solid nitrate of silver and sulphate of copper to a granular conjunctiva. If in such cases we evert the lid, we find a pale smooth cicatrix occupying its deep concavity. Partial or complete inversion of the margin of the lids may also result from contraction of the conjunctiva, following injury from acids, or caustic alkalies, or burns.

A great variety of operations has been devised for the cure of entropion. In that form, so common in old persons, where the inversion is owing to contraction of the orbicularis muscle acting upon a flaccid lid, a cure can usually be effected by removing an elliptical portion of the skin of the lid, together with the subjacent fasciculus of muscle, and then accurately uniting the wound with fine sutures. It requires care exactly to calculate what quantity of skin should be taken away; and of course the removal of too large a portion would cause eversion of the lid, and so produce a deformity of the opposite kind.

If the tarsal cartilage be so much curved that removal of skin is insufficient to draw the eyelashes away from the globe, recourse may be had to an expedient suggested by Mr. Streatfeild. The skin of the lid being carefully dissected up, sufficiently to expose the convex surface of the tarsal cartilage, a long narrow wedge-shaped slice is cut out from this, so as to form a groove extending the whole length of the tarsus. The curved cartilage thus becomes bent backwards, as it were, and the skin being restored to its position, is united along the cut edges with a few fine sutures.

Should all these plans fail, and the eyelashes still irritate the globe, the whole row must be dissected off, together with that portion of the tarsal margin in which their roots are imbedded.

Ectropion, or eversion of the lids, may exist in the most various degrees. Its worst form is seen as a result of burns of the face, followed by extensive contraction of the cicatrices.

A spasmodic form of ectropion is often seen in purulent ophthalmia of infants, and in scrofulous and irritable ophthalmia of older children. In infants the unsightly appearance of the bright red and swollen conjunctiva gives rise to great alarm in those who have the care of the child; but they may be assured that as the inflammation subsides, the deformity will gradually cease.

The chronic forms of *ectropion* in adults, which are produced by granular thickening of the conjunctiva after purulent ophthalmia, or by the contraction of cicatrices in the skin surrounding the palpebral aperture, the result of ulcers, burns, exfoliation of bone, &c., require a variety of operations, according to the special nature of the case.

When, after chronic ophthalmia, the everted conjunctiva of the lower lid presents a thick mass of granular excrescences, without any material elongation of the tarsus, or disease of the neighbouring skin, a cure may sometimes be effected by removing with scissors the greater portion of the palpebral conjunctiva, and then uniting the edges of the wound with very fine sutures. These may be left to ulcerate out of themselves, the lid being kept in proper position by the aid of a pad of lint laid along the margin of the tarsus, and fixed by means of several layers of lint saturated with collodion. In this way the lids are kept in contact with each other, and the apparatus need not be disturbed for several days. When the wound in the palpebral conjunctiva is closed, the loose stitches may be removed, and the pad of lint replaced until the cure is complete.

In very old and severe cases of ectropion, the tarsus becomes so much stretched, that, in addition to the removal of conjunctiva, it is necessary to take away a wedge-shaped portion of the elongated lid itself. Still worse cases, such as those resulting from burns or disease of bone, may require the formation of a new eyelid by the transplantation of a portion of adjacent healthy skin.

Trichiasis consists in an irregular growth of the eyelashes, the general form of the tarsus itself not being changed. Tinea ciliaris very commonly causes trichiasis, by inducing cicatrisation about the roots of the cilia. Sometimes three or four fine eyelashes present their points towards the globe, or even a single hair will grow in this direction, all the other hairs maintaining their natural position.

Trichiasis, when existing only to a slight extent, causes constant annoyance to the patient, by a sense of pricking, and by the constantly irritable and watery state of the eye which it induces. If only a few hairs grow irregularly, the removal of the entire tarsal margin need not be resorted to. The offending hairs must be carefully plucked out from time to time; or, if they form a little group, they may be removed by dissecting out the small portion of lid external to the tarsus itself, in which their roots are implanted, and then uniting the wound with a suture.

To draw out an eyelash by the root seems a very simple and trifling matter; and yet there are few surgical manipulations in which care and the skilful use of a well-made instrument are so necessary. The cilia forceps one commonly meets with are liable to cut the hair instead of merely grasping it firmly; and the stiff broken stump of a hair causes far more distress to the patient than its natural fine point. The hair should never be sharply jerked out, but removed with a slow steady pull.

INFLAMMATION OF THE LIDS.

The eyelids are of course liable to the various forms of inflammation which attack similar tissues in other parts of the body. A few inflammatory affections of the lids seem to demand notice on account of their presenting peculiarities of appearance, or being distinguished by special names.

A *stye* (*hordeolum*) is in fact a minute boil. It begins at the very edge of the lid, as a small, red, tense swelling, and at first is merely troublesome by the itching and sense of stiffness it occasions. As the inflammation goes on, the redness and swelling may more or less involve the whole lid, so that the eye becomes completely closed. In a few days matter forms, and shows itself at the summit of the stye; the cuticle gives way, pus and a small slough of areolar tissue escape; and then the redness and swelling subside, and the lid soon assumes its former appearance.

Scrofulous and delicate children are the usual subjects of styes, and they are comparatively rare in adults. Attention to the state of the bowels, carefully regulated diet, and the use of tonics, comprise the general treatment. Locally, warm water-dressings with lint and oiled-silk are greatly to be preferred to poultices, which are apt to irritate the skin. The stye should never be rubbed or squeezed; and no incision is necessary, except, perhaps, a slight puncture through the cuticle when the pus is pointing.

Abscess sometimes occurs in the Meibomian follicles. These organs pour out upon the edges of the lids a greasy secretion, which prevents the tears running over, and causes them to flow onwards to the puncta. Sometimes a follicle becomes obstructed at the orifice, and the retained secretion forms a minute solid granule, looking, when extracted, like a little grain of sand. If it projects sufficiently to touch the globe, a slight irritation is produced until the granule is removed.

If, however, the solidified secretion cannot in this way escape through the orifice of the follicle, it causes irritation, and at last a small abscess in the follicle itself. The lower lid is commonly the seat of these abscesses. They commence with a small patch of vascularity in the palpebral conjunctiva, a short distance from the free border of the tarsus, and gradually a yellow dot of pus forms in the centre of the vascular patch. If the conjunctiva at this point be punctured with a lancet, and a small scoop be introduced, the cause of the suppuration, a little nodule of stearine, about the size of a poppy-seed, may usually be turned out, and then all irritation subsides.

Tinea ciliaris,—termed also *ophthalmia tarsi*, *psorophthalmia*, *tinea palpebrarum*, &c.,—is one of the most common and troublesome diseases of the lids. It is too often neglected during the early stage, when alone it is really curable, and the Surgeon is probably consulted for the first time when many of the hair-bulbs have already been irreparably destroyed, and the remaining hairs are misplaced and inverted, constituting the state called *trichiasis*. This term is frequently employed as if synonymous with entropion, but it ought properly to be restricted to mean displacement of the *hairs* themselves, while entropion signifies a turning-in of the *lid*.

Tinea ciliaris is seldom seen in its early pustular form; for the little pustules at the roots of the eyelashes soon break, and the discharge exuded from them dries into crusts, which cling about the hairs, matting them together, and sometimes almost concealing them from view. Tinea ciliaris, if allowed to go on unchecked, gradually destroys the tissues which secrete the hairs; and when the disease has thus exhausted itself, and the last crusts have fallen off, the tarsi, instead of presenting sharply-beveled edges, appear rounded off, the skin and conjunctiva being gradually blended together into one smooth, red, shining cicatrix, in which neither cilia nor Meibomian orifices can be traced. Very often the puncta also become obliterated, and the tears consequently run over the cheeks, causing irritability and blinking of the lids. This is the condition to which the term *lippitudo* should be restricted; *tinea ciliaris* being understood to mean that state in which active disease at the roots of the eyelashes is still going on.

In the *treatment* of tinea ciliaris, the chief difficulty arises from the age of the patients. Daily attention is required, to prevent the accumulation of crusts, which should be carefully washed off night and morning. Patients often derive but little benefit from the remedies prescribed, in consequence of this regular cleansing being neglected. It is useless to apply ointments any where except upon the very surface of the minute sores at the roots of the hairs; and if the latter are kept closely cut with scissors, the application of ointments, and the prevention of crusts, are greatly facilitated. Of course, this cutting of the eyelashes requires to be done by the Surgeon himself, and the ointment should be neatly applied with a pencil. When cases cannot be thoroughly looked after, it is perhaps better to prescribe lotions, as they can hardly fail to reach the seat of disease. Ung. hydr. nitratis, ung. hydr. nitrico-oxydi, and ung. zinci oxydi, sufficiently diluted with ung. cetacei, or fresh lard, are the best ointments. The acetate of lead may be used as a lotion, in the proportion of from two to four grains in the ounce of distilled water.

The worst forms of lippitudo may often be greatly relieved by slitting up the canaliculi in the manner described at page 869. By this means the overflow of tears is checked, and this of itself is an immense comfort to the patient; while, at the same time, the tendency to ectropion, which long-continued lippitudo often induces, is considerably diminished.

Phtheiriasis. Among the irritable conditions of the eyelids, I may here notice that arising from the presence of lice. These creatures are "crab-lice" (*phthirius*), a species quite distinct from that which infests the scalp (*pediculus*). They thrust their heads into the skin at the roots of the cilia, and by means of the sharp claws with which all their legs, except the first pair, are provided, hold on so firmly, that they cannot be dislodged without great difficulty.

Phtheiriasis of the eyelids is an extremely rare affection, at least in this country, and I have met with only three or four instances, all of which occurred in children. On superficial examination, the cases are very similar to those of tinea ciliaris. The eyelashes present a powdery appearance, and their roots seem to be clogged with yellowish-gray and brown crusts; but by careful scrutiny of these supposed crusts, the movements of the insects may be detected; and the powdery appearance of the cilia will be found owing to their being clogged with the exuviæ of the creatures, and dried sanies from the wounds they have inflicted. They may speedily be destroyed by thoroughly smearing into the roots of the eyelashes the white precipitate ointment (ung. hydrarg. ammonio-chloridi).

MORBID GROWTHS OF THE LIDS.

The following are the more common swellings which appear in or upon the lids.

Cysts, of two distinct kinds. Those of the first kind, extremely common, are met with both in the upper and the lower lid (*Encysted tarsal tumour*, Tyrrell; *Chalazion*, Mackenzie); the others are found almost invariably at one spot, namely, just over the external angular process of the frontal bone, to the periosteum of which they are attached.

Molluscum is met with on the lids of children, and seems identical with the little masses termed by Tyrrell "glandiform," and by Mackenzie "albuminous" tumours.

Warts are sometimes found on the lids, differing in no respect from those on other parts of the body.

Nævi materni, resembling those of other parts.

1. *Cysts* of the lids are met with at all ages. They may exist singly, or several may appear together, coming successively to their full growth. The skin over them is quite unchanged, so that, when small, they are hardly recognisable except by the touch. They feel like half a hemp-seed or half a pea fixed by the flat side to the tarsal cartilage, and presenting a convexity towards the skin, which may be freely moved over them. They rarely exceed the size of a pea, except when suppuration has taken place within them.

If the lid be everted, the position of the cyst is recognised by a thinning of the tarsal cartilage, forming a dusky spot, around which the conjunctiva is reddened. These cysts may remain of a moderate size during life, without causing any inconvenience; but sometimes they suddenly inflame and become enlarged, the skin over them reddens and at last gives way, a small quantity of pus escapes, and afterwards a thin sanies continues to ooze from the aperture. But more commonly the pus makes its way through the palpebral conjunctiva, and then a little red fungous mass gradually protrudes, which, by the continual pressure of the eyeball, becomes flattened out into a mushroom shape.

When these cysts are so small as to escape ordinary observation, they require no treatment; but if they become so large as to be unsightly, and, still more, if they inflame and suppurate, they must be treated in the following way. The lid being everted, a crucial wound is made through the conjunctiva into the cavity of the cyst. If the inflammation has been acute, pus escapes, otherwise a little serum. A scooped probe passed into the cavity, and twirled about in various directions, brings out the accumulated epithelium, which has a jelly-like appearance. Blood then fills the cyst, and makes it as large as it was before the incision. The patient, however, may be assured that this swelling will gradually subside. To prevent premature closing of the wound, and refilling of the cyst, the probe should be used in the way just described every third day for about a fortnight. The walls of the cyst come together, and ultimately form a slight thickening in the lid, just perceptible by the finger applied to the skin.

Fibrous cysts, varying in size from that of a large pea to that of a hazel-nut, and containing sebaceous matter and hairs, are almost invariably confined to one situation, namely, just over the external angular process of the frontal bone. They appear to be congenital; at least, I have seen them of considerable size in infants four or five months old. The skin over the cyst retains its natural appearance, and it is only on account of the unsightliness that the Surgeon is consulted.

In dissecting out the cyst, which is the only mode of treatment, great care is requisite to avoid cutting into it; and especially while the cyst is being separated from the periosteum, to which it always adheres pretty closely. The cavity is lined by a smooth membrane, and is filled with white greasy material interspersed with loose hairs. In a cyst removed by one of my colleagues from an infant five months old, these hairs were still growing from the lining membrane. It seems that, in the course of years, these hairs may attain a considerable size, while the fatty material degenerates into oil. Such was the case in a very large cyst which I removed from a woman between thirty and forty. The skin had become so much thinned as to have assumed a dusky hue; and in endeavouring to dissect out the cyst I punctured it, and there escaped a quantity of perfectly clear yellow oil. There remained within the cavity only some detached black hairs, loosely curled together, and as strong as those of the head.

2. The little masses described by Tyrrell as "glandiform tumours" appear to be identical with *molluscum*, which attacks children in the form of small, white, rounded bodies, scattered over the lids, the alæ nasi, and about the corners of the mouth. When very small, these bodies are slightly reddish; but when as large as a pea, they are white, and exhibit at the apex a minute opening, through which a milky fluid exudes on pressure. The readiest way to get rid of these unsightly masses is to split them all through with a lancet, and then to nip out with the nails the contents of each. The mass, when pressed out, looks almost like a fragment of parotid gland.

3. *Warts* may be snipped off with scissors, the little wound being touched with nitrate of silver; or they may be tied at the base with a fine silk, and allowed to slough.

4. *Nævi* of the lids differ in no respect from those met with in other parts of the body; but they require more careful and discriminating treatment, on account of the importance of avoiding, as much as possible, any considerable loss of skin; a large cicatrix being not only in itself unsightly, but likely, by its contraction, to cause distortion of the lid. Subcutaneous ligature, therefore, or the introduction of probes coated with fused nitrate of silver, must be preferred to including any portions of skin within a ligature, or extensively destroying it with escharotics.

I have seen injections of alum cause sloughing of the lids and great subsequent deformity; and such a result might follow the injection of any similar fluid into the loose areolar tissue of the part, unless some contrivance can be used to restrain the fluid within proper limits.

In the following case an injection of tannin proved successful. A young lady was brought to me with a nævus on the upper lid, the size of a small hazel-nut. I was informed it had already been twice operated on by the introduction of threads steeped in nitric acid, and much inflammation and sloughing had ensued, as was proved by a considerable cicatrix of the skin near the outer canthus. The apex of the swelling was on the free margin of the lid, on everting which, a small bunch of veins, about the size of a barley-corn, was seen projecting through the tarsal cartilage, only covered by conjunctiva. The nævus seemed to be formed almost wholly by veins, the larger trunks of which could be felt through the skin, as they emerged below the supraciliary ridge.

Having enclosed the whole upper lid in a "ring forceps," I could completely isolate the nævus from its parent veins, and I then punctured it with a very small narrow knife (Hays's needle-knife), and cut up its tissue subcutaneously. Being emptied of its blood, the nævus collapsed; and I next, with a fine syringe, threw in a saturated solution of tannic acid. After a short pause, I relaxed the pressure of the ring forceps, and so allowed the returning blood to mingle with the injected fluid.

The subsequent inflammation produced a good deal of swelling and hardness of the lid; but the only slough was a mass about the size of a small pea, which made its way out at the little wound. The final result was complete obliteration of the nævus.

Carcinoma rarely commences in the lids, although it may spread to them from other parts. Should it be already far advanced when first brought under the Surgeon's notice, extirpation would hardly be attempted. Small, hard, suspicious growths at the margin of the tarsus may be removed by excising a wedge-shaped portion of the lid on which they grow, and then uniting the wound with sutures.

Epithelial cancer chiefly attacks the skin over the lacrymal sac, and from that point extends over the nasal and superior maxillary bones, having the appearance of a shallow pale ulcer, with an irregular outline and uneven borders, and with a scarcely perceptible quantity of secretion. Chloride of zinc, made into a paste, and applied over the entire surface of the sore, so as to include its edges, will sometimes very effectually destroy the morbid growth, and it may be reapplied whenever any part of the border of the sore begins to exhibit fresh activity. Of course, the strictest attention to general health would be combined with the local treatment.

INJURIES OF THE LIDS.

Ecchymosis. An effusion of blood into the areolar tissue of the lids, popularly termed "a black eye," is commonly the result of a blow; but it may arise from other causes, as, for instance, from the unskilful employment of leeches. The sufferer is always most anxious to get rid of the ecchymosis as quickly as possible; and I know of no treatment so efficacious as that handed down by the traditions of pugilism, consisting in the application of a poultice formed of the freshly-scraped root of the "black bryony" (*tamus communis*), mixed with a due proportion of linseed-meal or bread-crumbs. Poultices of this kind produce a stinging sensation in the skin, and, if regularly applied for a day or two, seldom fail in effecting a complete absorption of the effused blood.

Emphysema. This, like ecchymosis, is usually the result of a blow with the fist, which fractures some of the thin brittle bones, such as the lacrymal or ethmoid, forming the inner wall of the orbit. If, shortly after such an injury, the patient blows his nose, the eyelids suddenly puff up, so that he is unable to separate them. On pressing the part with the fingers, we at once perceive the peculiar crackling caused by the presence of air in areolar tissue. If the patient abstain from blowing his nose, the effused air soon becomes dispersed, and the swelling disappears.

Wounds of the lids have already been considered.* They are to be treated on the common principles of surgery which apply to other regions. The careful Surgeon would naturally be alive to the importance of obtaining the nicest adaptation of cut surfaces in parts so open to observation. The yielding nature of the skin of the lids, and its plentiful supply of blood, offer peculiar facilities for effecting close and smooth union of wounds by means of fine sutures, in applying which the greatest care must be taken to avoid any irregularity and puckering of the cut edges.

CHAPTER XII.

DISEASES OF PARTS WITHIN THE ORBIT.

Parts very dissimilar, as regards their structure and functions, are grouped together in the present Chapter; but they are all more or less concerned in supporting or imparting motion to the eyeball. The various morbid growths within the orbit, which cause displacement or impair the mobility of the organ, are also here briefly noticed.

PROTRUSION OF THE EYEBALL.

(*Proptosis oculi; Ophthalmo-ptosis; Exophthalmos.*)

Various causes may induce an unnatural prominence of the eyeball; but cases are sometimes met with in which this prominence seems of itself to form the whole morbid condition. The eyes have a remarkably staring expression, and look as if they were much too large for their sockets. The tarsi can be brought into contact; the eyes themselves move freely in all directions, and sight is unaffected. The equal amount of prominence in both eyes, and their unimpaired functions, at once remove any suspicion of orbital tumour.

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* See Injuries of the Face.

Women of feeble and hysterical constitution are the usual subjects of this deformity, the cause of which is very obscure. Atony of the recti muscles has been suggested; and no doubt a weakened state of these muscles might produce a certain amount of prominence of the eye, but would be incompatible with its free motion. I have never seen any cure or benefit result from treatment in these cases.

Dislocation of the eyeball from the socket is an accident we often hear of, but I need hardly say, that without rupture of the optic nerve the eye cannot be thrust upon the cheek, where it so often figures in the exaggerated accounts of patients. What really takes place is, probably, the lodgment of the upper lid behind the greatest convexity of the globe. I have seen this accident occur, when a Surgeon, anxious to explore the upper surface of the sclerotic, in search of a foreign body, or for some other cause, has too forcibly thrust back the upper lid. The tarsus, being forced beyond the summit of the eyeball, has suddenly slipped backwards, and become fast locked behind it. A wire elevator or a bent probe will enable the Surgeon to lift up the tarsus and restore it to its place.

Hydatids, cancerous growths, and exostoses, by encroaching upon the cavity of the orbit, all give rise to gradual displacement of the eyeball. As this displacement increases, the movements of the eyeball become more and more limited, until at last it remains quite fixed.

It requires much careful investigation into the history of the case to enable the Surgeon to determine the nature of the morbid growth. Exostoses are the slowest, and encephaloid tumours the most rapid in their progress. It is sometimes possible to pass in the tip of the little finger between the globe and the anterior portion of the orbit, and thus partially to explore the surface of the tumour. Hydatid cysts are recognised by a feeling of elasticity and fluctuation; and in doubtful cases a puncture with a fine trocar will sometimes reveal the true nature of the mass.

The removal of morbid growths from the orbit requires the utmost care to avoid inflicting injury upon the eye itself or the optic nerve; and, before attempting such an operation, the Surgeon should be well convinced that the mass is limited to the orbit, and has not extended into it from the cavity of the skull.

Abscess in the orbit occurs as a result of injury, such as the entrance of a foreign body; or it sometimes seems to be the effect of a chill. In a less acute form we meet with it as a sequela of fever and erysipelas. The suppuration is ushered in with rigors and depression; the conjunctiva and areolar tissue of the globe become red and infiltrated; the lids are swollen and livid; the eyeball becomes prominent and immovable; and at length fluctuation can be detected by the finger passed in between the lids and the globe. The rapidity with which these symptoms follow each other would serve to distinguish suppuration from the growth of a tumour. Until fluctuation occurs, the existence of pus in the areolar tissue of the orbit is very obscure; and the deep exploratory punctures which some surgical writers advise to be made between the eyelids and the globe must be very unsafe, considering how closely the eyeball is surrounded with muscles and nerves, which these random incisions would endanger.

Chronic abscess in the orbit is commonly the result of caries or necrosis; and the denuded bone will be felt by introducing a probe through the opening by which the pus has been evacuated.

Orbital abscess, even of the acute and so-called phlegmonous kind, so commonly occurs in depressed and feeble subjects, that light and nutritious diet, with a due proportion of stimulants, will be indicated, instead of abstinence and leeches. The bowels should be rapidly unloaded, and then narcotics given in doses just sufficient to soothe pain and induce sleep. Bark and ammonia, wine and other tonics, will often be needed in increased quantities during the free suppuration, which not uncommonly follows the opening of the abscess. Warm water-dressing will be throughout the best local application.

AFFECTIONS OF ORBITAL NERVES.

The eyeball and its appendages derive their sensibility from branches of the ophthalmic division of the *fifth* nerve, which not only endows these parts with feeling, but also so far influences their blood-supply that total anæsthesia of the nerve is followed, sooner or later, by deranged nutrition of the cornea, and by other phenomena generally described as "inflammatory."

These phenomena have been already noticed in the Chapter treating of Diseases of the Cornea; and at present we may confine our attention to those motory nerves which supply the muscles of the lids and globe,—namely, the third, fourth, sixth, and "portio dura" of the seventh, or facial.

The orbicularis palpebrarum is supplied by the last-named nerve, and when it is paralysed, the tarsi can no longer be brought into contact. If the patient is told to shut the eye, the lids remain immovable; if the paralysis is complete, or if it be only partial, a slight attempt at closure takes place. At the same time the eyeball is rolled upwards by the action of the superior rectus, as if seeking in that way the shelter of the upper lid. Sometimes the branch supplying the orbicularis palpebrarum is alone paralysed, but more frequently this is affected in common with the other facial muscles.

The orbital nerves, it will be remembered, are distributed as follows: the third to the levator palpebræ, the superior, inferior, and internal recti, and inferior oblique muscles; and also to the iris, through the medium of the ophthalmic ganglion. The fourth nerve supplies the superior oblique, and the sixth the external rectus.

It is not necessary that all the muscles supplied by one of these nerves should be affected at the same time, or to the same extent; but for the sake of illustration we will assume cases in which the various nerves have wholly lost their motory function.

The following are the symptoms of paralysis of the *third* nerve. The upper lid hangs motionless, and is in contact with the lower one (*ptosis*). On lifting it we find the globe abducted, so that the cornea faces towards the temple. The patient can direct the eye still farther outwards, but neither inwards, upwards, nor downwards. The pupil is dilated and fixed, and on that account vision, especially for near objects, is somewhat impaired, although the optic nerve and retina may be wholly unaffected. By looking through a small aperture vision becomes perfect. If the patient looks with both eyes at objects placed on that side of him towards which the affected eye is abducted, they appear single; while objects in the other direction appear double. If all the branches of the third nerve are paralysed, the inferior oblique muscle of course ceases to act, and the superior oblique having no antagonist, rotates the globe on its antero-posterior axis, and hence vertical objects seen with the affected eye appear oblique.

If the *sixth* nerve alone be paralysed, the eye is turned inwards. This inversion can be increased at will, and the eye can be freely moved upwards and downwards; the pupil is of natural size and active, and the upper lid retains its motions unimpaired. If the patient looks at objects on that side towards which the eye is inverted, they appear single; but objects in the other direction are double.

Paralysis of the *fourth* nerve is much less common than either of the two forms already mentioned, and, on account of the very slight change it causes in the position of the eye, is very difficult of detection. The paralysis is chiefly to be recognised by its subjective phenomena. If, for instance, the patient with both eyes open fixes his attention on some straight line on the ground, as the edge of a gravel-walk, or the curb-stone of a foot-pavement, he sees two lines, one in its real position, and the other forming with it a more or less acute angle. If with both eyes he looks at a near object, such as a large capital letter, at such an angle that it appears double, the image perceived by the affected eye will incline from the perpendicular, and its lines cannot be brought parallel to those seen by the sound eye, unless the patient inclines his head to one side. The letter T or a +, as containing right angles, are good forms for testing the defect.*

The *treatment* of paralytic affections of the orbital nerves must be based on a careful investigation into the symptoms of each individual case, for the causes of paralysis may be very various. Slow, and eventually total, paralysis of one or all the nerves which enter the orbit may depend upon chronic changes in the brain itself, or the dura mater, the growth of tumours, disease of bone, &c. Sudden paralysis may follow apoplectic effusion or other injury to the cerebral structure, or may depend upon rheumatic inflammation of the fibrous tissues immediately surrounding and investing the nervous trunks.

Of course the prognosis would vary greatly accordingly as one or another of these causes had induced the paralysis. In the case of chronic brain-disease, or the growth of intracranial tumours, the treatment could be only palliative. The probability of recovery in cases of apoplexy would depend upon the extent of the extravasation.

If one or more of the orbital nerves were suddenly paralysed, and at the same time other parts of the body were affected with loss of motory power, while the brain itself gave evidences of its whole circulation being disturbed,—there would be comparatively little chance of the orbital muscles recovering their function. But if the paralysis were so completely limited to one of the orbital nerves as to render it probable that only some minute vessel in the course of the motor-tract had given way, and had involved the adjacent brain-fibres, the absence of all other cerebral symptoms would warrant the hope that considerable improvement, or even complete recovery, might take place.

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* The use of the oblique muscles appears to be to maintain the eyeballs in such a position that their vertical diameters may be always kept parallel to each other during lateral inclination of the head.

By far the most hopeful cases are those where the paralysis of the orbital nerve can be traced to rheumatism; since a well-directed treatment of the general rheumatic diathesis will, in all probability, restore the affected nerve to a healthy condition.

STRABISMUS.

The various forms of mal-position of the eyeball just noticed, depending upon more or less sudden paralysis of the ocular muscles, might, according to strict etymology, be classed under *strabismus;* but, practically, the term is restricted to those chronic cases in which habitual mal-position results from irregular action of either the internal or external rectus. The deformity may be defined as a want of parallelism in the visual axes, when the patient endeavours to direct both eyes to an object at the same time.

Strabismus may be either *convergent* or *divergent.* In the former case the eye, or eyes, will be directed towards the nose; in the latter case towards the temple. The strabismus is termed "single" if one eye only is misplaced, and "double" when both eyes converge or diverge. In many cases which ordinarily appear as double strabismus, one eye becomes perfectly straight whenever the patient fixes his attention on an object; and the eye which thus for a time acquires a normal position will be found to have the stronger powers of vision.

In other instances of double strabismus both eyes maintain their inverted position, even while the patient is intently observing an object; but if the Surgeon suddenly closes one of these convergent eyes, the other at once becomes straight, resuming its inversion as soon as the other eye is opened.

"Divergent" strabismus is rare, except as a consequence of considerable loss of sight in one eye, persisting for several years.

The *causes* of strabismus are very various. When existing only to a slight degree, and alternating from one eye to the other, it will sometimes be found due to intestinal irritation, such as that arising from worms. In other cases, it may be traced to the temporary cerebral disturbance induced by teething, or to the more persistent form which attends hydrocephalus. An opacity near the centre of the cornea will sometimes cause an eye gradually to turn inwards, through a sort of instinctive effort of the organ to bring a clear portion of the cornea into use. Extreme shortness of sight may induce strabismus, by obliging the patient to make the eyes converge to an extreme degree, whenever they are employed upon near objects.

The more ordinary forms of strabismus, such as are daily brought before us, are first noticed in infancy, frequently at a period coincident with teething; but I think this cannot be, in most cases, the real cause of the strabismus, for extensive observation with the ophthalmoscope has shown me that, in the great majority of instances of confirmed squint existing in children, the optic nerves themselves are ill-developed, being usually smaller than natural, of a more or less oval form, and of a dusky colour.

The *treatment* of strabismus, as will be evident from what I have just said as to its causes, must vary according to circumstances. The removal of intestinal irritation; the use of tonics; the employment of concave glasses, to correct extreme myopia;—these, and many other means, may be useful to correct strabismus which is only temporary, or which arises from peculiarity in the visual focus of the eyes. In every case a careful ophthalmoscopic examination is the first duty of the Surgeon; and he should also take every possible care to ascertain that no organic disease exists in the brain or orbital nerves, and that there is no tumour in the orbit mechanically hindering the movements of the eye.

The *operation* for the cure of strabismus consists in the division of the muscle, which, in consequence of shortening, or too great preponderance in contractile power, is permanently drawing the eye either inwards or outwards. Division of the internal rectus, when first introduced, was performed in the following way. The lids being held apart by an assistant, a small sharp hook was stuck into the sclerotic, close to the inner margin of the cornea, so as to fix the eyeball and draw it outwards. Then the Surgeon, raising with a forceps a fold of conjunctiva midway between the cornea and plica semilunaris, divided it vertically with scissors, snipped through the sub-conjunctival tissue covering the tendon of the muscle, passed under it a blunt hook or director, and upon this divided with scissors, or with some kind of knife, either the tendon itself or the adjacent muscular portion of the rectus internus.

As in all other instances of manual surgery, the apparatus for performing this operation gradually became simplified. The spring speculum superseded the elevators held by an assistant; the sharp hook for fixing the globe was laid aside; and it was found that all the cutting could be done with scissors alone. The curious little knives, in every variety of form, which had been invented for dividing the muscle, are now for the most part forgotten; as are also the unseemly disputes about priority in trifling discoveries, and the exaggerated accounts of the uniform success which was stated to have attended the practice of certain strabismus operators.

We still occasionally meet with a fixed and leering eye which recalls the period of the first introduction of the operation in 1840; when, without the ophthalmoscope to facilitate diagnosis, every tyro fancied himself competent to cure a squint; and when the division of the muscle was attended with such extensive separation of the conjunctiva as to cause subsequent retraction of the semilunar fold, and a peculiar prominent appearance of the globe.

This latter deformity is now in a great measure obviated by sub-conjunctival division of the muscle. The lids are kept asunder with a spring speculum; and an assistant draws aside the globe, by nipping up with a forceps a little fold of loose conjunctiva near the margin of the cornea, at the opposite side to that on which the muscle is to be divided. Supposing the internal rectus to be chosen for operation, the Surgeon, with scissors, divides the ocular conjunctiva horizontally, on a level with the lower edge of the cornea, and extends the incision towards the semilunar fold. Then he snips through the sub-conjunctival tissue, and having exposed the sclerotic, slides upwards, between it and the rectus, a curved director. This serves to raise the muscle and make its fibres tense, and then with scissors the muscle is carefully cut through, close to its insertion into the sclerotic. This section of the muscle cannot be completed at a single stroke, but requires repeated use of the scissors, so that no fibres may be left undivided.

While this sub-conjunctival operation through a horizontal external wound obviates the retraction of the semilunar fold, it involves the risk of an imperfect division of the muscle, which is not exposed to the view of the Surgeon. A careful exploration with the blunt hook or director must be made to detect any undivided fibres, before the spring speculum is finally withdrawn.

Gräfe divides the conjunctiva on the equator of the globe a few lines from the cornea, passes a curved blunt hook beneath the muscle close to its insertion, and draws it into the conjunctival wound before using the scissors.

In dividing the *external* rectus, it must be borne in mind that the muscle is broader than the internal rectus, and is also inserted farther from the corneal margin.

Most cases of strabismus require the division of each internal rectus, even when the inversion of the better eye is but slight in comparison with the other. Instances, however, occur in which the inversion is wholly confined to one eye; and in such a case the faulty eye is alone to be operated upon.

No absolute rule can be laid down as to the use of chloroform in strabismus operations. In most cases it will be found necessary; but where patients are fitted by age, intelligence, and self-command to undergo the operation without chloroform, the doubt which sometimes exists as to whether the muscle has been effectually divided can be at once solved, by directing the patient to attempt inversion of the eye; a test not easy to employ when insensibility has been induced.

When, in searching for the muscle, the sub-conjunctival areolar tissue has been largely separated, it becomes infiltrated with blood, and forms a little prominence in the wound. The blinking of the lids gradually moulds this into a small button-shaped excrescence, attached by a narrow pedicle, which may be snipped through some weeks after the operation.

REMOVAL OF THE EYEBALL.

Certain diseased conditions of the globe may require a portion of it to be removed, while in other cases its tissues may be so extensively involved, and so much constitutional disturbance may in consequence arise, as to render necessary the total extirpation of the whole organ.

In non-malignant cases this operation is usually undertaken with a prospect of the patient afterwards wearing an artificial eye; and it therefore becomes important to consider whether a total or a partial extirpation will be best adapted to the end in view.

The enlargements which call for removal, on account of the deformity they occasion, are chiefly staphylomatous projections of the cornea or the sclerotic. Under the former term are commonly included projections which have really little or no corneal tissue within them, being formed of the iris coated over with fibrous tissue, after the true cornea has been partially or wholly destroyed by ulceration or sloughing. The sclerotic staphylomata, as they are called, are produced by gradual thinning and distension of the weakened fibres of the part, from accumulations of aqueous humour or of serum. In some of the latter cases the eyeball acquires a very large size, and is extremely unsightly, on account of the dark leaden-coloured projections of the sclerotic, and the large tortuous veins which ramify over it. When the cornea has been extensively destroyed by sloughing or ulceration, it very commonly happens that the lens escapes through the breach; when this does not take place, the lens frequently becomes filled with a deposit of phosphate of lime, and this earthy mass, by pressing against the ciliary processes and iris, often causes severe neuralgia. In excising a staphyloma, therefore, the opening should be made sufficiently large to allow the lens, if still existing, to escape.

In operating, the lids must be held apart with a spring speculum or the fingers of an assistant. The Surgeon then passes a cataract-knife through the staphyloma, and forms a flap, which he seizes with a forceps, and removes with a second stroke of the knife; if the lens presents at the opening, it is to be quickly tilted out with a scoop, and then the lids are instantly to be closed, and a cold sponge applied firmly over them. This immediate pressure is the most likely means for preventing hæmorrhage from the enlarged choroidal vessels, which sometimes takes place the moment the fluid contents of the globe have escaped. Moderate pressure should be kept up until the risk of bleeding has gone by, and then water-dressing will be the only application required till the parts are healed. The portion of the globe left after the excision of a staphyloma gradually shrinks to a nodule, and as soon as this has ceased to be tender, an artificial eye may be applied.

If, in consequence of the sudden removal of the pressure which the accumulated fluids of the globe had been exerting on the choroidal and retinal vessels, the latter give way, and blood fills and distends the cavity of the sclerotic, extreme pain is the result, and it may even be thought desirable at once to extirpate all that remains of the globe, with the view of preventing future suffering.

Total extirpation of the eyeball. This operation, except when malignant disease exists, should never be resorted to, so long as any sight remains in the organ; unless it should be so irritable as to lead the Surgeon to fear that, by sparing it, the sight of the fellow-eye may be endangered. Restricted within due limits, and not undertaken through a morbid love of operating, extirpation of the eyeball is a ready means of relieving patients whose whole system may have become impaired by long-continued neuralgia, arising from distension of the globe, or lodgment of foreign bodies within its cavity.

Extirpation of the eyeball, which was formerly effected by scooping out all the contents of the orbit, has been greatly simplified by the adoption of Bonnet's operation, whereby the globe alone is removed, by making a circular incision through the conjunctiva and ocular fascia, and then successively dividing each muscle of the eyeball close to its insertion, and the optic nerve just before it pierces the sclerotic.

The operation usually consists in raising with a hook all the tendons of the ocular muscles, and dividing them before cutting through the optic nerve.

I prefer the following plan, as simpler and more rapid. Having inserted the spring speculum between the lids, and made with curved scissors the usual circular incision of the conjunctiva, I grasp the external rectus and its surrounding tissue with a forceps, and snip them through; an assistant at once seizes the cut tendon close to its insertion, and draws the eye inwards. By sliding one blade of the scissors under the superior oblique and rectus muscle, they can be divided, and then the inferior rectus. The optic nerve is next snipped through, and the globe starts forward. A few strokes of the scissors divide the inferior oblique, internal rectus, vessels, and bands of areolar tissue, and the operation is completed. Cold water and exposure to the air suffice to arrest the bleeding, and then water-dressing is all that is required.

USE OF CHLOROFORM IN OPHTHALMIC SURGERY.

We may regard chloroform under two aspects: as saving the patient from pain, and as facilitating the manipulations of the Surgeon. Now it is well known that operations performed on the globe itself cause little pain, and last but a very short time. Those on the lids, involving as they do the wounding of skin, are of course more painful; but none of them are in this respect comparable to the larger operations of general surgery; and there are few adults who, if properly informed as to the real nature of such operations as those for cataract, artificial pupil, and strabismus, will not readily undergo them without the aid of anaesthetics. There are, however, many timid and anxious persons who are quite unable to go through the operations for artificial pupil and strabismus except under chloroform, and very few without its aid can encounter extirpation of the eyeball. It is also occasionally necessary to induce insensibility in order to examine eyes rendered irritable by disease, or by the presence of foreign bodies. In children all ophthalmic operations are greatly facilitated by the use of chloroform, and some can hardly be performed without it.

If a perfectly passive condition of the eye is so desirable during the delicate operation of extraction, one would naturally expect to find chloroform peculiarly indicated in such a case. But it forms a special exception, for the following reasons. We have already seen (p. 830) that, when the operation of extraction has been properly performed, a successful result chiefly depends upon the rapidity with which union of the corneal wound can be effected. Now, with every precaution in the administration of chloroform, it will occasionally induce sickness; and the effort of vomiting may cause the vitreous body to escape through the opening just made in the cornea, thus inducing prolapsus iridis, with all its consequent irritation and hindrance to union of the wound. But, even without assuming so extreme a case, we shall find a very serious objection to chloroform in the nausea and disrelish for food which often follow its inhalation, whereby the nutrition and reparative power of the cornea become impaired during the critical twenty-four hours immediately following the operation.

JAMES DIXON.

END OF THE SECOND VOLUME.

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90